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CIVIL ENGINEERING.

*Experiments to Ascertain the Effects of Grades and Curvature on Railways.** By Alfred Sears, C. E., U. S.

So long as the clay in which we are moulded is of grosser fabric than the mind, so long as the hand is harder than the brain, just so long will machinery of all sorts fall in its practical application below the standard of duty marked out for it by the formulæ of the philosopher. When we have ceased our labors to elevate man, we may withhold our efforts to perfect his work.

Hence, then, till a result is accomplished, that shall render experience unnecessary, experience will be interesting and valuable. If the result obtained from data furnished by properly conducted experiments be found to modify accepted doctrines—they aid in bringing formulæ into practical shape, and thus, too, they produce a still nearer approach to *perfectness of adaptation* in the machine to which they apply.

Of especial importance are the recent experiments on the New York and Erie Railroad. In the subjects they reach, they are more extensive, in the influence they must exert more considerable, and in the effects, measured by a financial scale, as valuable as any other class of data that can be gathered from railroad practice. They yield truths to be regarded by the constructing engineer, and convey important suggestions to those having charge of the working of railroads—while they are also of interest to the locomotive machinist.

The object in view, at present, is to introduce the result obtained, more especially to the notice of the civil engineer and railroad superin-

*From the Lond. Civ. Eng. and Arch'a. Jour., Feb., 1856.

tendent. They will give additional data for the calculation of the much vexed question "of the equation of distances," an important problem in engineering, and one that has been subject to much confusion. As to gradients, the cause of the difficulty is, that many eminent men, who should have known better, have confounded the *angle of repose* with the *angle of double resistance.*

The latter cannot be a constant quantity, but is governed by the circumstances of the load and its portage. The *angle of repose*, on the contrary, may for practical purposes be assumed as constant, 0° 09′ according with the latest experiments. This angle produces an inclination of which the rise is ·258 of the length of the plane, equivalent to a grade of 13·7 feet in a mile—or referred to resistance to motion, is equal to a friction of 5·8 lbs. per ton.

This supposes the plainest case, being that of a car on a track without joints, and moving with a velocity indefinitely slow, a case in which atmospheric resistance amounts to practically nothing, the motion indicating only that friction is balanced. The amount of power used to produce this result is called the friction of the train. It expresses, however, but the friction of the cars of the train.

A comprehensive thought will at once convince the engineer of the fallacy in that equation by which this simple element is made the only resistance encountered or worth estimating.

The *angle of double resistance* varies with the load—the style of the engine—the velocity. Other causes affect it, but these are the principal, and are always present. Hence, in estimating the value of different lines, it is important to consider the kind of business to be accommodated; whether chiefly a passenger or freight traffic; light trains at high rates of speed, or heavy trains at less velocities.

This paper will present those results only that are founded on reliable data. It will, therefore, be necessary to avoid all consideration of works accomplished by extraordinary methods, and expedient to omit notice of those miles that are of such mixed construction in grade and alignment as to compel calculations on short sections with the use of *averages*—a dangerous element in such problems.

Those situations of the trains on descending grades, in which the breaks were locked, are of course incidental to all railway locomotion, but form no part of the phenomena to be now considered.

The organization of the trial train was completed on Monday, August 27. Operations began on Tuesday. The train left Dunkirk, the western terminus of the New York and Erie Railroad, at as early an hour as the state of the track would permit; a dry rail being necessary to a fair exhibit of the adhesive power of the engine.

The engine No. 210 was appointed to the performance of these duties.

Weight of engine,	66,000 lbs.
Weight of engine on drivers,	40,000 lbs.
Diameter of blast orifice,	2½ in.
Diameter of cylinder,	1417 ft.
Diameter of driving wheels (coupled),	5 ft.
Length of stroke of piston,	2 ft.

These figures are necessary elements in the calculations incidental to the experiment.

The formulæ made use of are those of De Pambour; and I have adopted the practical co-efficients determined by his experiments, when they have not been expressly ascertained for this purpose.

The experiments were made with heavy trains, the composition of which was regulated by the "ruling grade" of the various divisions of the road. These trains weighed, on different occasions of the trip, including engine, tender, and caboose, as follows, viz:—train designated for convenience

No. 1, composed of 25 cars, . . .	982,140 lbs.
No. 2, " 30 " . . .	1,145,790 "
No. 3, " 100 " . . .	3,545,390 "
Weight of tender, roadworthy, .	42,240 "

The width of the Erie railroad gauge is 6 feet.

To illustrate what has been said concerning "Equating for Grades," it will be interesting to estimate the amount of resistances to be overcome with some of these different loads before they can be moved on the track.

1. The atmospheric pressure of 14·7 lbs. an inch on each piston of which the area is 227 inches, may be reckoned as $2\times227\times14{\cdot}7=6674$ lbs. But as the power of the engine is directed to the circumference of the drivers, it will be necessary to find the value of this element of resistance at the same point, to establish a relation between them as well as between this and the other resistances. The pistons travel two strokes measuring 4 feet, while the wheels make one revolution during which they have passed through 15·71 feet. Hence the proportion

$$15{\cdot}71 : 4 = 6674 : x = 1699 \text{ lbs.}$$

2. The back pressure resulting from the construction of the blast orifice, and which depends on the velocity of the engine, may be represented when referred to the periphery of the driver by

$$\frac{4\times454p}{15{\cdot}7}=116p,$$

in which p = back pressure in pounds per square inch. Hence, then—

$$1699+116\,p =$$

the resistance in pounds arising from atmospheric pressure on the pistons and the action of the blast pipe.

3. Let T = number of tons (gross) composing the load, including tender, and f = friction of load, being the number of pounds required to move one ton upon the track; in this case 5·7 lbs. Then

$$f\,\mathrm{T} =$$

resistance opposed by the friction of the load.

4. Let g = effect of gravity in pounds per ton, and W = weight of engine in tons gross, then

$$g\,(\mathrm{T}+\mathrm{W}) =$$

the effect in pounds produced by the gravity of the train; to be added to or deducted from the other resistances, as the grade is ascending or descending.

Then

$$f. \pm g\,(T+W), \text{ or } T\,(f \pm g) \pm g\,W =$$

the resistances opposed by the friction of the load and the gravity of the train.

5. We come now to estimate the resistance occasioned by the air through which the train is moving, and which must be considered as at rest, since no observations were taken to measure the amount of its effect. The amount of frontage may be called equal to the greatest cross section of the train increased by 10 square feet for each car, including engine and tender.

Let bv^2 = this resistance in pounds at the velocity v of the train; then

$$f.\,T \pm g\,(T+W) + bv^2 =$$

resistance from friction of load, gravity of the train, and the air.

6. One other obstacle to the progress of the train remains to be considered—the friction of the engine.

Let F = the friction of unloaded engine, being in this case 348 lbs., or 12 lbs. per ton.

Let r = additional friction due the load, to be measured as a fraction of the resistances summed up in (5), being for coupled engines about 22. Then

$$F + r\,[f.\,T \pm g\,(T+W) + bv^2]$$

will be the friction of the engine, when moving with the resistances here indicated. And we have for the *sum of resistances* encountered by this engine, when referred to the track,

$$S = 1699 + 116\,p + F + (1+r)\,[f.\,T \pm g\,(T+W) + bv^2]$$

Let us reduce this equation for a velocity of 23 miles per hour, being the average speed of train No. 1 during 2·26 miles, the most unexceptionable on a level tangent, as to attending circumstances; pressure in the boiler as indicated by the steam gauge being 124 lbs.

P = atmospheric pressure on pistons, in lbs. .	1699
$p = 8$; then $116\,p =$	928
F = ...	348

$g = 0$

$f = 5{\cdot}7$ lbs. per ton gross.

T = 438 — 29 = 409 tons gross.

W = 29 tons gross.

Frontage of train = 110 + 28 × 10 = 390 square feet.

$bv^2 = 390 \times 1{\cdot}6$ lbs. = 624 lbs.

$1 + r = 1{\cdot}22$.

Hence then

$(1+r)\,[f.\,T \pm g\,(T+W) + bv^2] =$ . .	3605
and S =	6580

This amount of resistance is equivalent to the gravity on a grade of 35·3 feet per mile, which is the *grade of double resistance* for this train at a speed of 23 miles per hour, with a steam pressure of 124 lbs.

Train No. 2 with the same pressure in the boiler was removed 3·5 miles at the rate of about 20 miles per hour on a level tangent. In the same formula

$$p = 6\ ;\ \text{then } 116\,p = 696 \text{ lbs.}$$
$$S = 512 - 29 = 483 \text{ tons gross.}$$

Frontage and effective surface of train is $110 + 33 \times 10 = 440$ square feet.

$$bv^2 = 440 \times 1{\cdot}2 = 528 \text{ lbs.} \quad \text{Then } S = 6746 \text{ lbs.}$$

Gravity will equal this amount of resistance on a grade of 31 feet per mile.

Hence, then, other things being the same, we find that for train No. 1, moving with a velocity of 23 miles per hour, the grade demanding an outlay of power double the amount required on a level, is 35·3 feet per mile. In other words, for this train, one mile of 35·3 feet grade ascending, would equal two miles of level line. While for No. 2, moving at 20 miles an hour, the power must be doubled on a grade of 31 feet per mile.

Concerning the effect of velocity, we observe that with a load nearly one-fifth greater, the resistances are increased but 5 per cent. if the speed be reduced 43 per cent.

Thus, when a sufficient number of experiments have been made with care, it will be found valuable to prepare a table of results, and from this table the locating engineer may, with sufficient accuracy, determine the "equation of grades," for the class of road he is about estimating.

Though these reflections are independent of the experiments we are to consider, it is hoped they may not be thought useless. Nor will they, when it is remembered that important errors are frequently made by those who assume a constant quantity in "equating distances" on lines under investigation for estimates. So great is the error that not even an average can be made for trains presenting considerable differences in their composition.

In examining the data collected in a series of experiments on the effect of curvature, we shall notice greater departures from a formula based on any one, than in cases of grades on tangents. This will be the case in the present instance; for while on some parts of the road the track is properly prepared by bending to the curves, it is in other cases laid more carelessly, and is in some of the sharpest curves nearly straight. So that in passing from rail to rail the resistance from concussion is by no means inconsiderable.

In the following table will be found the results condensed, of all the reliable data gathered on 200 miles east from Dunkirk. The cases are gleaned from the mass and averaged; a practice, that, as before remarked, is dangerous, where entire accuracy is sought, yet one to which it is necessary to resort, unless the experiments are conducted with especial reference to this use. And even then, the results obtained on various roads, must be averaged for the construction of reliable tables for practical purposes.

The results are arranged to proceed from the simplest case to the most complicated, and are numbered as separate experiments. The first four

in the list are the average of many observations, and are used as corrections for the curves.

General Characteristic of Line.	Number of experiment.	Number of Train.	Grade—Ascent in feet per mile.	Alignment.	Total Amount of Curvature in Degrees.	Boiler Pressure indicated by steam gauge in lbs. per sq. inch.	Effected Vaporization in cubic feet of water per hour.	Velocity actually accomplished, in miles per hour.	Velocity demanded by formula, on Tangent.	Difference for correction, in miles per hour.	Diff. due Curv. expressed as a fraction of the effect demanded
					°						
Level Tangent,	1	1	0	Tangent,	—	124	210	23·0	23·7	0·7 } av.	—
" "	2	2	0	"	—	124	190	19·9	20·9	1·0 } 0·8	—
" "	3	3	0	"	—	130	141	8·0	8·0	0·0	—
Ascend'g Tangent,	4	2	40	"	—	130	141	7·0	7·0	0·0	—
Level Curve,	5	1	0	1° Curvature,	53	125	210	22·5	23·7	0·8	·01
" "	6	2	0	3° Curvature,	158	110	165	16·0	18·3	0·8	·08
" "	7	1	0	Compound 1° 2° & 3°	85	120	165	18·3	20·0	0·8	·045
" "	8	1	0	" 1¼° & 3°	82	120	165	17·9	20·0	0·8	·065
Ascending Curve,	9	1	24	1° Curvature,	53	120	155	12·6	13·2	0·4	·014
" "	10	1	40	4° "	211	130	136	5·4	7·4	0·0	·27
" "	11	1	40	3° "	158	115	137	5·9	7·5	0·0	·21

To ascertain the effect of curvature, we shall first examine the resistances opposed to each train as if on a tangent, then the total resistance actually overcome by the train on the various curves. The difference between those results will be the amount of resistance due curvature.

De Pambour's formula for the velocity at which a certain load may be drawn by a locomotive is used, with a change in the symbols for the convenience of those whose duties call them to know more of railroads than the dead languages.

The formulæ will then stand—

$$V = \frac{1}{5280} \cdot \frac{1}{q} \cdot \frac{1}{1+c} \times \frac{E}{(1+r)\left[(f \pm g)T \pm g W + bv^2\right] + F + \frac{d \cdot l}{D}\left(\frac{n}{q} + a + 144\,p\right)} =$$

velocity in miles per hour, when

E = Effective vaporization of the engine, in cubic feet of water per hour.

q = Factor expressing volume of steam proportioned to the pressure = ·00000023 when the pressure is given in pounds per square foot.

n = Constant quantity relative to the volume of steam, its value being ·0001421.

l = Length of stroke of piston.

c = Clearance of the cylinder, equal in this instance to $\frac{1}{3\frac{1}{2}}$ of the useful stroke of the piston, which gives $\frac{1}{1+c} = \frac{22}{23}$.

a = Atmospheric pressure, equal to 2117 lbs. per square foot.

d = Diameter of cylinder.

D = Diameter of driving wheel.

The total heating surface of the boiler = 1105 square feet. The diameter of blast orifice should have been stated at 3 inches. The equation when reduced by the substitution of these values will read—

$$V = \frac{798\ E}{1{\cdot}22\ [\ (5{\cdot}7 \pm g)\ T \pm g\ W + bv^2] + 348 + 0{\cdot}8\ (2736 + 144\ p)}$$

To illustrate the use of this formula, let us apply it to the circumstances of train No. 1. We shall have by making proper substitutions, the equation

$$V = \frac{798 \times 210}{1{\cdot}22[5{\cdot}7 \times 409 + 624] + 348 + 0{\cdot}8(2736 + 1152)} = \left\{ \begin{array}{l} 23{\cdot}7 \text{ miles} \\ \text{per hour.} \end{array} \right.$$

It is thus we arrive at the amounts stated in the table under the head of "Velocity Demanded."

It is to be noticed that in the experiments on level tangents, the actual effect is somewhat below the estimated powers of the engine; also, that, as the velocity increases, the difference becomes greater.

This was perhaps to be expected. During a part of the time the adhesive power of the driver was affected by a leakage of the pumps, which wet the rail. The track is, moreover, exceedingly rough in places; though the quantity given above, as the friction of the cars, being 5 lbs. per net ton, is in accordance with information received from the general superintendent of the Erie road.

In addition to these causes of difference, it may be remarked that there was at times some wind; but as these are culled instances, it is believed they are free from any considerable influence beyond a quiet atmosphere. In No. 1, at a velocity of 22 miles per hour, there is a difference between the actual and possible effect, of 3 per cent. of the work done.

In No. 2, at a velocity of 20 miles per hour, this difference amounts to 5 per cent.

In No. 3, the velocity being 8 miles per hour, the difference was too slight to be noted.

In No. 4, at a velocity of 7 miles per hour, the difference was equally unnoticeable.

Suppose there be similar relations throughout, these amounts must for practical purposes, be applied as corrections to the experiments on curves.

If, therefore, the amounts in the column of differences be added to the velocity actually accomplished, and the sum be deducted from the velocity demanded, we shall have presented the effect of curvature, which in the table is noted as a fraction of the effect demanded, after correction.

It would be useless of course to found a law on these results. They are believed to be most carefully observed, and so far as they go are certainly correct. What are noted as single experiments, are really classes of observations. But we must have more considerable data from many roads before the results obtained can be made available for the purposes of the locating engineer—who, as before remarked, must be governed by the nature of the business to be done on the lines under consideration.

*On the Causes of Explosions of Steam Boilers.** By Mr. William Kemble Hall, United States (America).

The different theories advanced to explain the action resulting in explosions, were examined and illustrated by the ordinary attendant facts. Inherent defects in design and material were sufficiently provided for, by the preliminary testing and the ordinary safety valve, and the deterioration by use could be guarded against by periodical examination. If the pressure of the steam was allowed gradually to increase, until it exceeded the strength of the boiler, the danger would be betrayed by some one of the numerous rivets and seams of its structure, as there was always some single point which would first give way. In the boiler which exploded on the 18th of August, at the Hartford Steel Works, Sheffield, the steam was at its usual working pressure of 40 lbs. per square inch, when a rupture took place in the side of the boiler, from which the steam issued with a furious hissing sound, warning the attendants of their danger and enabling them to escape. The side stays were defective and had failed. It was reasonable, then, to suppose, that the tearing of the boiler into several pieces, which generally accompanied explosions, was caused by a sudden exertion of power, and electricity had been suggested as an agent. But although electrical phenomena might be exhibited by the expansion of a jet of steam, it could not be supposed, that a boiler, with its many direct and metallic connexions with the earth, could be converted into a reservoir of electricity. If any were generated, it would be instantly conducted away. It had been supposed, that the plates exposed to the action of the fire by the falling of the water had become overheated and decomposed the steam, the oxygen of which had combined with the iron, and the hydrogen formed a gas, that had caused the explosion. But hydrogen would not explode, unless largely mixed with atmospheric air, which could not enter the boiler, except in minute quantities, forced through the feed-pump, in combination with water; and although there was evidence of the absorption of oxygen, in the rusting of the stays and of the interior surface of old boilers, it was too insufficient in extent, to warrant the deduction, that there had been an appreciable change in the chemical composition of the steam. It might be possible to produce an external explosion, but not an internal one.

In the explosion at the Consett Iron Works, Gateshead, early in November, it was in evidence, that the boiler had been blown out a short time previous, and the valve was not closed. The plates had been heated red hot, and it was supposed, that the attendant, who was killed, had discovered the deficiency of water, and had just opened the feed valve, at the instant when the explosion occurred. Now, heat did not lessen the strength of iron up to the temperature of 550°, and had it exceeded that point, in this case, and thus weakened the boiler, the result would merely have been a collapse of the flue. Water was not resolved quickly into steam by a red hot surface. The excessive heat repelled the particles, and they were slowly evaporated by the communication of heat through the intervening vapor. No great pressure, therefore, could have been

* Read before the Institution of Civil Engineers; London, March 4th, 1856.

generated directly from this source. When heat was applied to steam, the increase of its pressure was governed by the same law that applied to air and all other elastic gases;—an addition of 480° only doubling its pressure. Experiments had conclusively proved the possibility of heating steam in contact with water, without also increasing the temperature of the bulk of the water, the upper stratum of which alone became heated by the contact. If, therefore, it was supposed, for example, that the steam had been heated to 435° Fahrenheit, and water suddenly injected into it, the pressure would have been instantly raised to that due to the presence of the water,—determined by the experiments of Arago and Dulong to be 360 lbs. per square inch at that temperature. Or, to use another illustration, while 1000° of heat applied to steam, would but increase its pressure, or volume, about three-fold, the same amount would multiply that of water 1700 times. This vast increase would certainly be modified, by the latent heat absorbed by the water in its conversion into steam, but served to indicate a sudden and local generation of excessive pressure, which might result in explosion.

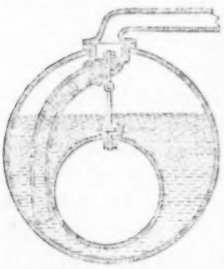
The surcharged steam might be supplied with water, without the agency of the feed pump. At the explosion which occurred at Chiswick, July 16th, when the safety valve was in good order, and loaded to the average working pressure of 20 lbs. to the square inch, the boiler had been idle during the dinner hour, and the explosion occurred as the engine man was in the act of opening the stop valve, preparatory to starting the engine. The water had probably been low, and the sudden flow of steam into the pipes, partially relieved the water of pressure, and it was thrown by the agitation into intimate contact with the super-heated steam, and suddenly converted into vapor of too high a tension for the strength of the boiler. It was a well known fact, to those conversant with the practical management of steam boilers, that the water stood higher, when the engine was in operation, than when it was idle, and that it might be further raised by opening the safety valve. This effect was more apparent with a contracted water surface, and comparatively small steam room. An explosion which took place at the Tower Mills, Shetfield, August 11th, was an illustration. The surviving attendants positively affirmed, that observations of the water gauges, a few minutes previous to the accident, showed sufficient water; but an Engineer, deputed by the Coroner for the purpose, examined the boiler, and testified that it had been overheated, and that such indication was wrong, or had been misunderstood. The boiler exploded immediately after the attendant had made some preparation necessary for opening the safety valve, and probably at the instant he had opened it. The boilers that exploded at the Walker Iron Works, at Newcastle, October 8th, and at the Kebblesworth Colliery, September 19th, were each provided with a float and two safety valves. In both instances there was reason to believe that the water had been forced through the connecting feed pipe, from the boiler that exploded, into the adjoining one, and that in the latter instance, the attendant had observed the danger, and was engaged in opening the safety valve.

Experience had proved, that the fusible metal plug, enjoined by law in France, became encrusted by scale, and otherwise rendered inopera-

tive by use, and did not answer the purpose for which it was intended. The softer portions of a compound metal were forced out by the pressure to which it was subjected, and the remainder becoming oxidized, did not fuse at the temperature intended. It, moreover, acted merely as a warning, and did not serve to obviate the impending catastrophe.

All the contrivances hitherto adopted for the purpose of providing against explosions, were designed to supply water, when that in the boiler had fallen to too low a level, or to open the safety valve by the pressure of steam, independent of other circumstances. As had been illustrated by the examples alluded to, either of these plans would induce, in many instances, the very accident designed to be avoided. For there seemed every reason to believe, that the great majority of explosions were occasioned by the negligence of the attendant, in permitting the level of the water to fall below the flues, exposing the plates to a high temperature, and surcharging the steam with caloric, far exceeding that due to its pressure. In injecting an additional supply of water into the boiler, when in this dangerous condition, it was thrown over the heated plates and into the super-heated steam, and suddenly converted into steam of too high a tension for the boiler; and so instantaneously, moreover, that it operated with all the momentum of a blow. And as the water necessary to produce this disastrous result might be supplied to the surcharged steam, from that already in the boiler, by the agitation incident to the opening of the so-called safety valve, the alarming fact was presented, that the very instrument provided for insuring against explosions might become the cause of producing one.

Fig.1. HALL'S APPARATUS.



These considerations naturally led to the conclusion, that safety was alone to be attained, by opening a water blow-off valve, when the surface of the water had fallen to a perilous extent, for the purpose of first discharging from the boiler the water, which was the more dangerous element, and then the steam; operating, in fact, as a safety valve, in a more useful but less objectionable position than the present steam-valve situated on the dome. The arrangement reperesented by the wood-cut illustrated the principle; it represented a valve communicating with the water, and kept in position by a rod which served for its stem, and terminated in a button cemented with tin, or other readily fusible metal, into a copper cup, riveted to the crown of the furnace. There were no working joints, or stuffing boxes, to become disordered, and the fusible metal was protected by the cup, composed of a material which was a rapid conductor of heat. If the furnace should be unduly heated, the button would be released, and the valve permitted to open and discharge the water and steam from the boiler. The boiler might be injured, and the flues destroyed by the fire, but no explosion could occur. This system had been subjected to trial under heavy pressure, and had been found very successful.

In the discussion, it was argued, that Mr. Hall's system, if properly carried out, would be extremely useful, and almost prevent the possi-

bility of danger from explosion; but that it would be of use only when an explosion was almost inevitable, and that as prevention was better than cure, the utmost should first be done to prevent boilers reaching that state, still retaining Mr. Hall's valuable apparatus, in cases of all other means of prevention proving ineffectual. The majority of explosions were stated to arise from the practice of constructing the boilers with the fire-places in the flues (fig. 2), contrary to the system used in Cornwall, where they always arranged to have abundant boiler room and slow combustion; but where flue firing was used, the boiler surface was too frequently deficient, and the firing rapid and generally forced. Plans were exhibited, showing this peculiar danger to be caused by the severest action of the fire being, of necessity, within the concavity of the fire flue, upon which there was but a few inches depth of water, and where the least neglect in its supply, would be fatal to the boiler plate, even if a repulsive action did not already cause a remittent rather than a constant action of contact of water with the plate; besides which, the probability of the water, below the fire bars, not boiling at all, rendered the supply of steam weak, and easily exhausted, and led to undue firing and all its concomitant evils. The furnace constructed of masonry (fig. 3) was described as promoting the reverse of all these conditions. Many extracts, from known writers, bearing on the subject, were given, and it was attempted to be shown, that while there were fully as many under-firing as tube-firing boilers, at work, the majority of explosions took place in boilers of the latter class, and they almost invariably commenced with the collapse of the fire flue.

Fig. 2. Internal flue firing.

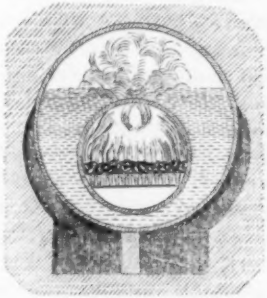
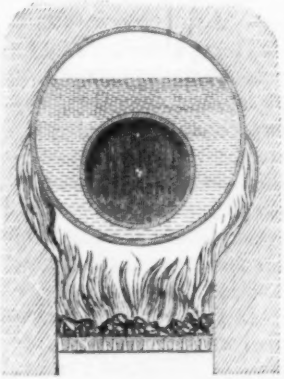


Fig. 3. Under-firing.



It was contended, that the only objection which could be raised against under-firing, was the danger of incrustation, or deposit upon the boiler bottom, of matter held in suspension by the water; but that this rarely, if ever, caused explosions; the utmost injury it occasioned, was causing the boiler plate to be burnt out, and that this effect could not take place, without gross neglect. The questions of the possibility of saturating surcharged steam, so as to dangerously increase its power;—of hydrogen gas being formed in the boiler, and other theories of a similar nature, were avoided, as it was held, that each of these, supposing their possibility, must arise from the presence of unduly heated metal within the boiler, which it could not be doubted was the prime cause of nearly all explosions, and that a properly set under-firing boiler could never, except from the most culpable neglect, have any portion of its surface over-heated. It was also suggested, that, when it was necessary to stop the engines, instead of

closing the damper, it would be safer to leave it open, to close the ash-pit door, and to keep the fire door ajar.

The possibility of the water being repelled from the top of the flue, as shown in fig. 2, was contested, and it was argued, that the water would rather have a tendency to rise up the two sides of the tube, on account of the fire being in immediate contact with the side plates, and thus that the two currents would cause the water rather to heap up over the flue.

Many flue boilers were injured, by the flame being allowed to impinge too sharply upon certain parts, and in those spots the plates blistered, and were soon burned through; the best remedy for this was to give more flue space; and it would be found, that the quantity of steam generated would be increased, whilst the burning of the boiler would be prevented. In many cases of explosion, especially of locomotive boilers, it was evident, that the pressure had increased very gradually, and the steam had become surcharged with heat, so that when the explosion occurred, all the water was suddenly flashed into steam, as the rails and ground all around were quite dry.

It was doubted, whether the fusible metal might not, in practice, become partially fused, at a comparatively low temperature, and allow the valve to open prematurely; and it was urged, that it was safer to depend upon the care, skill, and intelligence of the engine-man, than upon any self-acting apparatus. Many serious accidents, particularly on railways, had arisen from the attendants being lulled into fancied security by having self-acting points, or other apparatus, which worked well for a time, until something went wrong, and then an accident ensued.

The flues frequently collapsed in consequence of their losing their circular shape by pressure, or from originally imperfect construction.

The spheroidal theory of M. Boutigny (D'Evreux) was discussed, and a doubt was expressed, whether any considerable quantity of water could be brought into the same state as the small quantities, upon which his experiments were tried. It was, however, contended, that if a boiler was heated to a very high temperature whilst empty, and the water was then suddenly injected and the aperture closed, an explosion would not occur instantly, because the water would have assumed the spheroidal state; but as soon as the temperature was reduced to the proper degree, the steam would be liberated in such a volume, and at such a density, as to burst the boiler.

In Cornwall, where it was acknowledged that the utmost economy of fuel was practised, the boilers were stated to be nearly all on the internal flue principle, and an accident was scarcely ever known to occur there. It was generally admitted, that the apparatus introduced by Mr. Hall, would be effective in preventing accidents, but that the main point was to have very ample boiler space, have no self-acting apparatus, and encourage great attention on the part of the engine attendant.

A new form of boiler was exhibited, and described as having been recently erected at the works of Messrs. Humphrys, Tennant & Dykes; the fire-box, of 3 feet diameter, was composed of a series of flanched rings of Low Moor iron, fastened together in such a manner, as that the rivets should be surrounded by water, and not be exposed to the action of the fire. The depth of water over the fire-box would be double that

over the small iron flues, or tubes, which were three inches diameter. No double thickness of plate was allowed anywhere. It was intended to supply steam of 70 lbs. per inch, and it had been loaded up to 120 lbs. per inch. The shell was much stronger than that of one of the Great Western locomotives, and it was anticipated that the steam might be permitted to accumulate without danger.

Several instances were given of explosions of locomotive boilers, presenting many apparent peculiarities, which were, however, all referable to natural causes; in some cases, a series of very peculiar circular holes, and in others grooves were found, extending all round the interior of the shell, near the rivets. The boilers had failed below the part where they were weakened by the bending over, probably a little too sharply, of the plates.

When it was remembered, that the explosion of a boiler, under a pressure of 140 lbs. per square inch, was nearly identical with that of a 10-inch gun, the effects of such an occurrence were not surprising.

In the cotton mills, the speeds of the machinery were increased, whilst the boilers became weaker from wear; under such circumstances, the occurrence of accidents was scarcely to be wondered at. When steam ceased to act merely by pressure and began to exercise momentum, peculiar effects must be anticipated; but they might all be traced to general, rather than to occult causes.

It was stated that nearly, if not quite, all the instances of explosions, recorded in the *Journal of the Franklin Institute*, were from boilers with under-firing, and they were generally considered in the United States, as less secure than those with internal fire-flues.

It was stated, relative to the explosion at Sheffield, that it was proved there had been a sufficiency of water over the tube, and yet that one portion of it must have been red-hot; at least, such was the appearance exhibited. It was contended that the effect of heaping up the water from the action of the side-plates, was not nearly so probable, as the repulsive action of the top of the flue, previously contended for; inasmuch as the latter action was more probable and natural. Also, that if, as had been stated, the water below the flue was unduly cooled at that part, the steam would be weak and deficient in quantity. It was reiterated, that if a boiler was of due strength, properly set, and carefully attended to, there was little danger of explosion, until the plates were too much weakened by wear and tear. With all boilers, Mr. Hall's apparatus would be a valuable adjunct, and in no case could be prejudicial.

The double-flue Cornish boiler was mentioned as being preferable to the single firing-flue; the surface exposed was more extensive, and the construction was stronger—the depth of water above the flues was greater—and firing could be alternate. All these were admitted advantages.

It was reiterated, that it was not necessary to have recourse to the spheroidal theory—to the decomposition of water—or to any highly scientific arguments, and much less to mysterious, or occult causes, for the reasons of explosions. Careful investigation would in general point sufficiently clearly to them, when the reasons were fairly sought for.

It was stated, that the observed cases of corrosion of the plates of boilers, might be referred to galvanic agency, and instances were given

of such effects being produced, when the bilge water was taken up by the feed-pumps and injected into the boilers. The sections of metal torn asunder, frequently presented proof of an instantaneous generation of explosive power, whether produced by over-heated plates, or any other cause; and as the method of discharging the water and the steam from a boiler, would appear to be the most effectual mode of preventing danger, it would be only reasonable to employ so simple a precaution as that afforded by Mr. Hall's apparatus.

The opinion as to the little confidence to be placed in self-acting apparatus, in general, was agreed with; but it was submitted that the self-acting looms, and other machines of that class, and the automatic action of the eccentric upon valve gear and other similar arrangements, would warrant deviation from the rule, under certain circumstances, among which it was claimed to place that of the spontaneous discharge of the water and steam from the boiler, in cases of a dangerous degree of pressure being attained.

The experiments of Watt and Southern were alluded to, as demonstrating that the latent heat of steam, at high temperatures, was progressively converted into thermometric heat, and the injection of water into surcharged steam would occasion a proportionate increase of pressure. A careful investigation of this subject, would probably confirm the alleged result of the experiments undertaken for Mr. E. K. Collins, of New York, which appeared to be that a saving of nearly 50 per cent. of fuel might be made by the use of surcharged steam.

The decomposition of water on heated plates, although admitted to be an interesting chemical study, was now generally rejected, as a practical solution of the question of explosion; and as to the spheroidal theory, any such pressure of steam as must exist within a boiler, would practically force the water into absolute contact with the heated surface, and would not permit the globules to be suspended amidst the film of steam, at atmospheric pressure, as in an open crucible, or on a plain heated plate. Therefore that theory must almost be abandoned in practice.

The causes of explosions might, at first sight, appear to be difficult of discovery, but careful investigation generally brought to light evidence of some condition of the boiler, under which an accident would be inevitable. The difficulty of arriving at the facts was great, after the occurrence of explosions, but there were few cases which did not exhibit undue weakness in some parts of the boiler, or undue steam pressure, without adequate means of affording relief.

In the case of the explosion of the locomotive boiler which had been mentioned, it was well ascertained, that the cross stays upon the fire-box top were rather too short, and thus had their bearing inside, instead of upon the exterior periphery. Explosions might be generally attributed to equally simple causes, and it was impressed on the meeting to seek for them, rather than to raise theories upon some occult causes, the existence of which was very problematical.

Mr. Hall's apparatus might, with advantage, be applied to all boilers, but it would be more useful if, as an invariable adjunct, it could take with it a careful, intelligent fire-man, without which no boiler could be considered safe.

AMERICAN PATENTS.

List of American Patents which issued from March 18th, to March 25th, 1856, (inclusive,) with Exemplifications.

MARCH 18.

95. For an *Improvement in Welding Steel;* Homer Anderson, Garrattsville, N. Y.

Claim.—"The compound of sulphate of soda and carbonate of soda, made up and used for welding metal surfaces."

96. For an *Improved Bench Plane;* Lewis C. Ashley, Troy, New York.

Claim.—"Combining a metallic throat piece with a plane stock, in a manner independent of the plane iron, to keep the mouth of the throat of the plane perfect, as the plane stock shall wear away."

97. For an *Improved Apparatus for Roasting and Broiling by Gas;* James B. Blake, Worcester, Massachusetts.

Claim.—"The roaster and boiler."

98. For an *Improved "Dumb-jockey," the "Cross" and Saddle-tree being made of Gutta Percha;* Samuel Blackwell, Middlesex County, England; patented in England, March 9, 1853.

Claim.—"Making the cross and the saddle-tree of gutta percha, and thus a new article of manufacture."

99. For an *Improvement in Hermetically Sealing Preserve Cans;* Charles Branwkite, City of New York.

Claim.—"Confining the top of the can between bearing surfaces, by means of the collar and screw, thereby dispensing with solder or cements, in forming a joint. Also, the peculiar form given to the internal and external bearing surfaces of this attachment for closing a can when formed."

100. For an *Improvement in Hernial Trusses;* John Broiles, Madison County, Ala.

Claim.—"The peculiar adaptation of the steel ribbon to the body of the patient, by making its lower edge flared out, the block or circle end flared out on its upper edge, for about two inches—the strap end slightly curved upwards, and the block end curved downwards and outwards on its upper edge, in combination with a pear-shaped pad, having a slice taken off, commencing at the outer edge of the base, and continued to about two-thirds its length towards the seam, thus forming a broad plane surface, to be applied to the body of the patient."

101. For an *Improvement in Grain and Grass Harvesters;* Thomas D. Burrall, Geneva, New York.

Claim.—"1st, The shoe piece and rack, to adjust the height of the outer end of the finger board. 2d, The arrangement of the shaft in the journal, with its pinion taking the wheel when combined with the bent arm."

102. For an *Improvement in Making Chilled Castings;* William Butler, Little Falls, New York.

Claim.—"The combination of the hollow chilled cones with the sand core, for the purposes of obviating the difficulty of warping and springing, attending the casting of cast iron boxes on chills, and thereby forming a chamber in the box."

103. For an *Improved Carriage Coupling;* Thomas Chope, Detroit, Mich.

Claim.—"Attaching the perch of a vehicle to the front axle, in a manner which will enable it to turn or rock, by means of a slotted T shaped bar, which is attached to the front axle, by means of clips—and the slides—both working in the slots, at right angles."

104. For an *Improvement in Threshing Machines;* Hiram Clark, Princeton, Mass.

Claim.—"The use of the pieces for separating the grain, by an action similar to that of a flail, in connexion with the rollers and aprons, or other similar device."

105. For an *Improvement in Mowing Machines;* Samuel Comfort, Morrisville, Penn.

Claim.—"The employment in mowing machines, of an endless chain of cutters, which shall traverse along the cutter bar, and a sufficient distance above the same, to allow the mown grass to drop between the said chain."

106. For *Improvements in Machines for Corking Bottles;* Henry N. De Graw, Piermont, New York.

Claim.—"Securing corks in bottles and other vessels containing liquids charged or impregnated mechanically with carbonic acid gas, by having proper cork holders attached to the bottles or vessels, and closing the jaws of the same by the levers and jaws, or other analogous device, immediately after the corks are forced into the bottles by the piston, so that the holders will secure the corks in the bottles as soon as the piston is withdrawn from them, whereby the corks are secured in the bottles without removing the bottles from the bed or platform of the apparatus, and consequently, the operation of charging the bottles with gas, placing the corks therein and securing them in bottles, performed at one operation."

107. For an *Improvement in Fire Places;* Calvin Dodge, Pittsburgh, Penna.

Claim.—"The use of a deep recess or chamber, placed back of the fire basket of the grate, and out of the reach of the draft, in combination with the horizontal covering over the recess and fire basket, extending down below the mouth of the chimney, for the purpose of consuming the smoke and causing the ignition of the gas, which would otherwise be lost, and thus increasing the amount of heat thrown into the room, and by the slow combustion of the fire, effecting a great saving of fuel."

108. For an *Improvement in Grain and Grass Harvesters;* Eliakim B. Forbush, Buffalo, New York.

Claim.—"1st, The adjustable shoe, for the purpose of leveling the platform. 2d, Suspending the pole to which the team is attached, from a hinged journal upon the axle of the driving wheel, in order that the draft of the team, when moving forward, may be directly from the axle of the driving wheel, (leaving the frame, finger bar, and cutters, free to oscillate, and independent of the pole and the draft of the team,) and also, when backing, the power of the team may be exerted upon the frame, in rear of, and below the axle of the driving wheel."

109. For an *Improvement in Feed and Blow-off Apparatus for Steam Boilers;* Jacob Frick, Philadelphia, Pennsylvania.

Claim.—"Arranging a check valve and stop and blow-off valve in one instrument for steam boilers, for the purpose of avoiding the attachment of the separate and distinct connexion hitherto employed for the same purpose. 2d, The pressure valve with its weighted lever, as connected with the alarm valve, and as arranged with the check and stop valve."

110. For an *Improvement in Seeding Machines;* John German and C. B. Haigh, Oriskany Falls, New York.

Claim.—"Having the elbow lever upon a screw rod, so that said lever may be moved in and out of line with a portion or all the pins on the wheel, for the purpose of causing the slide to be operated faster or slower, or to remain stationary."

111. For an *Improved Inkstand;* R. Gleason, Jr., Dorchester, Mass.

Claim.—"The use of the hollow elastic body, in combination with the peculiar valve employed, for the purpose of retaining the ink within the cup."

112. For an *Improved Nut Machine;* Robert Griffiths, Alleghany City, Penna.

Claim.—"The use of the compressions, punchers, saws, levers, crank, and traveling head, for the purpose of making nuts from heated bars."

113. For an *Improvement in Harvester Cutters;* Horace L. Hervey, Quincy, Illinois.

Claim.—"Furnishing the cutter bar with a series of inclined blades or knives, in combination with a series of inclined blocks, or their equivalents, for giving to said cutters, or cutter bar, an oblique cut."

114. For an *Improved Mortising Tool;* A. C. Hitchcock and C. H. Amidon, Greenfield, Massachusetts.

Claim.—"The combination of the bit with the hollow slotted chisel."

115. For an *Improved Arrangement of Rotary Planing Knives;* Daniel N. Hurlbut, Utica, New York.

Claim.—"The arrangement of the cutters, and manner of securing them to the cutter rim of the wheel."

116. For an *Improved Illuminating Grating;* Joshua K. Ingalls, Brooklyn, N. York.

Claim.—"1st, The spheroidal lens, or pane with rounded edges, set in gearing or perforated plates of wood or metal. 2d, The grating of wood or metal, with tapering apertures, and glazed with lens or panes, of the form and in the method set forth."

117. For an *Improvement in Processes for Making Transparent Window Shades;* Edward R. Kernan, Pittsburgh, Pennsylvania.

Claim.—"The making of flexible or pliable and semi-transparent oil cloth for window shades and other similar purposes, by a series of processes."

118. For an *Improvement in Churns;* Lucius Leavenworth, Freemansburgh, N. Y.

Claim.—"The arrangement of the cords or bands attached to the pulley, and also to the staff, being wound on the staff to give a required rotary motion."

119. For an *Improved Self-Regulating Wind-wheel;* A. Lempche, Pleasant Mount, Pennsylvania.

Claim.—"The spiral spring, or its equivalent, in combination with the weighted levers."

120. For an *Improvement in Percussion Projectiles;* John Lippincott, Philadelphia, Pennsylvania.

Claim.—"The combination of the cylindrical chamber, piston, spiral spring, cap and nose piece, forming an improved percussion apparatus, to be inserted into the powder chamber of bomb shells, either in combination with or without a shallow sabot of lead, of the shape described."

121. For an *Improvement in Stoves;* James B. Maybury, Jeffersonville, Indiana.

Claim.—"The surrounding the fire place of a stove of any size or form, with at least two or more air jackets, standing in no communication with each other, admitting no currents of heated air, to circulate through them, and each of them provided with only one valve, for the purpose of controlling the radiation of heat from the outermost shell of the stove without interfering with the fire in the interior thereof."

122. For an *Improved Machine for Felling Trees;* Ebenezer Mathers, Morgantown, Virginia.

Claim.—"The method of straining the saw, by means of the curved elastic arms, and the adjustable bar."

123. For an *Improvement in Cone Tubes for Winding Frames;* John M'Crone, Thompsonville, Connecticut.

Claim.—"The use of the crystal as a material, for the cones or trumpets, used for shaping and consolidating yarn of woolen, cotton, or other materials, on bobbins."

124. For an *Improvement in Processes for Making Elastic Rubber Cloth;* Richard M'Mullin, New Brunswick, New Jersey.

Claim.—"Rendering vulcanized india rubber for the manufacture of shirred goods adhesive, by boiling it in a solution of potash, to remove the sulphur from its surface—thus fitting the sheet of rubber to receive a coat of cement, whereby it is caused to adhere firmly to the cloth, or other fabric, between which it is placed."

125. For an *Improvement in Seed Planters;* Elijah Morgan, Morgantown, Virginia.

Claim.—"In combination with the dead hoppers, the chamfering or beveling of the ends of the seeding bar, and the scolloping of the shield, so that any grain that may be carried to the ends of the seeding bar, may be forced by it into said dead hopper."

126. For an *Improved Machine for Making Clothes Pins;* George W. Parker, Fitz-William, New Hampshire.

Claim.—"The use of holes in a wheel, or of tubes secured to a wheel, and into which the pieces of wood are fed, and are thus retained in, and carried forward to the proper position to be acted upon by the lathe, saw, or bit. 2d, A sliding or vibrating lathe and

tail block, whereby the pieces of wood to be turned, are carried forward to the action of the cutters, or chisels. 3d, The cutters or chisels, in combination with the lathe and poles. 4th, In combination with the holes, a saw, or bit, and a sliding or vibrating carriage or holder, or its equivalent, to convey the pieces from the holes to the saw or bit."

127. For an *Improvement in Sectional Fire Pots for Stoves and Furnaces;* Merritt Peckham, Utica, New York.

Claim.—"Forming the fire pot of stoves, furnaces, &c., of sections, when said sections are constructed and secured together."

128. For an *Improvement in Boxes of Railroad Car Axles;* David R. Perkinpine, Philadelphia, Pennsylvania.

Claim.—"The movable piece, the vertical portion of which forms the front, and the horizontal portion of the bottom of the box, in combination with the preparations, and groove on the latter, for the purpose of quickly exposing the whole interior of the box, for examination or cleaning, and as quickly covering the same."

129. For an *Improvement in Harness Buckles;* Nathan Post, East Cleveland, Ohio.

Claim.—"1st, Attaching to a three barred buckle, the flanches, which keep the trace or straps in the centre of the buckle. 2d, The tube on the centre bar made loose, so as to revolve thereon. 3d, The block or foundation, with its stationary tongue."

130. For an *Improvement in Omnibus Registers;* James Rodgers, City of New York.

Claim.—"The mode of locking the ratchet wheel, by making the operating pawl pass at the end of its motion, beneath or against the ratchet teeth, so as to lock the wheel in place."

131. For an *Improvement in Machines for Sawing Marble in Taper Form;* Charles A. Shultz, Chicago, Illinois.

Claim.—"Adjusting the saw, by means of the swinging pulleys, acting laterally upon it, with the pulley regulating the tension."

132. For an *Improved Mode of Producing Designs on Wood;* Philipp Schwickardt, Brooklyn, New York.

Claim.—"The production of veins, streaks, drawings, pictures, and designs, on the plane surface of the woods, by means of pressure; the forms or dies, and the application of the same, for the production of views, streaks, drawings, pictures, and designs; the exclusive use of the design produced through the body of woods, when compressed between proper forms, and the combination of two or more kinds of woods, to produce the mosaic or inlaid work, by compressing, joining, and separating them."

133. For an *Improvement in Adjusting the Brasses of Connecting Rods;* John R. Sees, City of New York.

Claim.—"The combination of the bridge piece and the wedges."

134. For an *Improvement in Nail Plate Feeding Machines;* John P. Sherwood, Fort Edward, New York.

Claim.—"The use of the grooved eccentric cam, with its friction roller and bar, in combination with the slotted cylindrical cam, nipper handle, and female screw, operating to produce the peculiar movements necessary for feeding the nail plate in nail machines."

135. For an *Improvement in Sewing Machines;* Isaac M. Singer, City of N. York.

Claim.—"The method of distending or gathering up the cloth or other substance, where the needle operates upon it to form the seam, by combining in a sewing machine, two distinct feeding wheels, or their equivalents, moving with a differential motion."

136. For an *Improvement in Machinery for Making Hat Bodies;* A. B. Taylor, Newark, New Jersey.

Claim.—"The arrangement for hardening the hat body in a dry state, by machinery. Also, the method of facilitating the removal of the bat from the perforated cone, by means of a blast of air forced through the cone."

137. For an *Improvement in Harness for Shoeing Horses;* William P. Thomas, Hillsboro', Indiana.

Claim.—"1st, The combination of the windlass with the traces, the tugs, tail lever,

or single-tree—these or their equivalents, by means of which the horse is brought to his place, and secured from lateral motion. 2d, The combination of the windlass with the ropes and the hames—these, or their equivalents, by means of which, the horse is prevented from rearing or moving backward. 3d, The combination of the cords with the pulleys, the breeching and the traces, such an arrangement of the parts, that the breeching is firmly held in its place, by the weight of the horse. 4th, The combination of the back band with the pawl, the pulley, the rope, and the breeching—these, or their equivalents, by means of which, the horse is prevented from raising his hinder parts, and the breeching is prevented from rising up. 5th, The sliding bar, by which the horse is prevented from pulling his foot away, while the front shoes are being driven on."

138. For an *Improvement in Argand Lamps for Burning Resin Oil;* Isaac Van Bunschoten, City of New York.

Claim.—"Deflecting a portion of any passing draft or current of air, up the exterior air tube, by means of the wings, or their equivalents, to counteract the suction, or partial vacuum, produced at the other portion of the lamp, by said passing draft or current of air. 2d, The wings, or their equivalents, applied around the wick tube, to cause any sudden draft or current of air, to be deflected with equal force up into the cone and external draft, and down into the drip cup and internal draft. 3d, The separate transparent cone, within the chimney, rising only to about the height of the button. 4th, The sleeve or cup, combined with the perforated wick tube, and inclosing said perforations."

139. For an *Improved Adjustment in Boring Machines;* Israel W. Ward, Birmingham, Pennsylvania.

Claim.—"Having the cylinder in the curved axis and the shaft in the straight slots cut in the pillar blocks, and uniting the journals by the braces, so that they may be adjustable, but always be held in gear with each other. Also, the hollow auger shanks, so arranged as to slide over the stationary shafts, as they are forced out or drawn back."

140. For an *Improved Method of Suspending Circular Saw Spindles;* Hiram Wells, Florence, Massachusetts.

Claim.—"The arrangement and application of the eccentrics, with respect to the shaft boxes, and their stationary and adjusting screw pieces."

141. For an *Improvement in Stripping Top Flats of Carding Machines;* George Wellman, Lowell, Massachusetts; patented in England, Nov. 25, 1853.

Claim.—"1st, The combination of the segmental gear, with its projecting rim, and the pinions with their attached notched plate wheels, all as applied to the shafts, for the purpose of giving the alternate intermittent movements to the shafts. 2d, The arrangement of the mangle pins, &c., in the arc of a circle, upon the centre of which, the frame carrying the stripping apparatus vibrates, for the purpose of avoiding intermediate gearing, and consequent back lash. 3d, The combination of the cams with the chain belt, the chain pulleys, and shaft. 4th, The combination of the cams with the levers, carrying and operating the stripper card. 5th, The combination of the cams with the lifting rod and the levers. 6th, The combination of the springs and the pins, and their application to the frame. 7th, A mechanism for cleaning the stripper card. 8th, The segmental gear and its rim, as applied and operated, for the purpose of giving motion both to the mechanism, for raising, stripping, and depressing the top card, and to the mechanism; the moving and stopping mechanism from one top card to another—not moving both at the same time, but alternately first one and then the other."

142. For an *Improvement in Spinning Wheels;* Lyman Wight, Benton, Penna.

Claim.—"Attaching the spindle of a band spinning wheel, to a vibrating pendulum, and operating the same."

143. For an *Improved Machine for Tunneling Rocks;* Charles Wilson, Springfield, Massachusetts.

Claim.—"1st, The circular formed as a short hollow truncated cone, for acting on stone or other material. 2d, A continuously revolving wheel, provided with circular rolling disks or cutters, the axis of which cutters stand alternately in opposite directions, or nearly at an angle of 45° with the shaft of said cutter wheel—thereby acting to excavate the rock or other material. 3d, The arrangement of the alternating inclined tapering planes and stocks, for the purpose of sustaining and adjusting the alternate rolling cutters. 4th, The construction of the shaft, cylinder, and parts attached, when

used in connexion with the socket, set screw, and binding strap. 5th, The general arrangement of the cylinder and shafts and gearing attached, for rotating the drum and pressing the same forward."

144. For a *Safety Apparatus to be Applied to Harnesses and Thills of Vehicles;* Jas. H. Wilson, Jr., Nashville, Tennessee.

Claim.—"Attaching the horse directly to the shafts of one horse vehicles, by means of the boxes, which are secured to the harness, a box at each side of the box—the boxes being constructed of two hinged or jointed sides, so that they may be opened when necessary by the driver."

145. For an *Improved Method of Adjusting Reciprocating Saws;* J. Z. A. Wagner, Philadelphia, Pennsylvania.

Claim.—"1st, Having the saws within the saw sash or gate, on or to nuts, which work or are fitted on right and left screw rods. 2d, Operating or adjusting the saws laterally in the saw sash or gate, by means of the pinion placed loosely on the shaft, so that said shaft may work freely through it, the shaft having bevel pinions at its ends, which pinions gear into corresponding pinions at the outer ends of two of the screw rods. 3d, Connecting and disconnecting the screw rods, by means of the levers and arm."

146. For an *Improvement in Cut-off Gear for Steam Engines;* Orville Leonard, Somerville, Mass., Assignor to self and George H. Reynolds, Medford County, Mass.

Claim.—"The rocker, the toe, and the bar."

MARCH 25.

147. For an *Improvement in Propelling Vessels;* Lambert Alexander, City of N. Y.

Claim.—"Regulating the motion of the propelling buckles, by the combined action of the spring blocks, inclines, rollers, and inclines."

148. For an *Improvement in Needle Guns;* Gustav A. Blittkowski and Frederick W. Hoffman, City of New York.

Claim.—"1st, The method of withdrawing the needle, by a positive force applied thereto, by means of the knob upon the needle stock, in combination with the claw upon the end of the hammer, so arranged, that becoming disengaged at the moment of giving the blow, it shall cause the withdrawal of the needle in the operation of cocking. 2d, The guide tube, for the double purpose of guiding the needle, and acting as a stop around the touch hole."

149. For an *Improvement in Detaching Boats from their Tackle;* Charles H. Key, Baltimore, Maryland, Administrator of S. F. Blunt, deceased.

Claim.—"The use of the weight of the boat when out of the water, to keep in place the contrivance for sustaining it, so that it shall no longer be sustained when the boat takes the water, and the weight is transferred to the latter."

150. For a *Machine for Cutting Loaf Sugar;* Adolph and Felix Brown, City of New York.

Claim.—"1st, The application and use of two or more rollers having brushes around their circumferences, and acting upon both sides of slabs of sugar, for the purpose of cleaning off the dust adhering to the same, by the process of sawing, thereby reproducing the appearance of the crystals. 2d, The application of drums or rollers connected together by gearing, having steel knives inserted and attached around their circumferences, forming squares and corresponding to each other, and acting on both sides of sugar slabs simultaneously like pincers, for the purpose of cutting up said slabs into regular morsels."

151. For an *Improvement in Breech Loading Fire Arms;* Ambrose E. Burnside, Bristol, Rhode Island.

Claim.—"1st, The use of a cartridge case made partially or wholly of soft metal, in combination with the beveled mouth in rear of the barrel, and the movable chamber of a breech loading fire arm, for the purpose of packing the joints thereof. 2d, The movable cartridge case, operating to eject the empty cartridge case."

152. For an *Improvement in Regulating the Flow of Oil to the Wick in Carcel Lamps;* Abraham Coates, City of New York.

Claim.—"Regulating the supply of oil to the burner, by means of the self-emptying drip cup, operating upon the supply valve."

153. For an *Improvement in Presses for Pinching;* George H. Corliss and Elisha Harris, Providence, Rhode Island.

Claim.—"The oscillating box, applied and operating within a yoke."

154. For an *Improvement in Fruit or Grain Dryers;* Charles W. Davis, Newark, New Jersey.

Claim.—"The inverted earthen cone, having an adjustable parabolic rim, with or without the hoop."

155. For an *Improvement in Stone Drilling Machines;* Josephus Echols, Columbus, Georgia.

Claim.—"1st, The cylinder with the apertures in its heads; the double valve with its hollow stem, and the tube with its cups. 2d, The gripper, operating in combination with a ring to grip and let go the drill bar. 3d, Furnishing the interior of one of the metal cups with spiral vanes, to be acted upon by the water, for the purpose of turning the bar at every stroke."

156. For an *Improvement in Paddle Wheels;* Calvin Fletcher, Cincinnati, Ohio.

Claim.—"The construction of propellers with a series of narrow buckets, of curvilinear or parabolic shape, for the purpose of combining the greatest propelling force with the least possible resistance to the ingress or egress of the buckets, in their passage through the water."

157. For an *Improvement in Water Coolers and Filterers;* John S. Gallaher, Jr., Washington, D. C.

Claim.—"1st, The application of combined chemical refrigerative agents, salt, charcoal, and gypsum, and a mechanical evaporating or air chamber, formed with a convex, inverted conical sloping or tapering cover or top, and a corresponding bottom part combined in use with a saturated cloth, and through all of which means, the ascending diffuse vapor is condensed, accumulated, and returned into its original volume, purified and cooled at the same time simultaneously. 2d, In combination with the condensing medium, and chemical refrigerative agents, the purifying or filtering devices, with the capillary agents and porous disks, through all of which chemical action and mechanical devices, is produced a compact individual, or unity cooling filtering apparatus."

158. For an *Improved Lath Machine;* Jesse Gilman, Nashua, N. H.

Claim.—"The clutch, operated by or through the medium of the lever and cams, in combination with the rods, carriage, and pulleys, the pulleys being connected respectively with the carriage and rod by the cords."

159. For an *Improvement in Steam Radiator Cocks;* Stephen J. Gold, New Haven, Connecticut.

Claim.—"The automatic closing of the cock on the filling of the radiator with steam, by means of a loose disk in the head of the cock."

160. For an *Improved Miniature Case;* Halvor Halvorson, Boston, Mass., Assignor to Slocum and Watkinson, Hartford, Connecticut.

Claim.—"The combination of the metallic dished bearing plate, the leather or embossed covering, and the two frames, the whole constituting one portion, or half of the case. Also, in combination with the metallic confining frame, and the velvet covered glass holder and frame—the frame made of pasteboard or other equivalent."

161. For an *Improved Pile Driver;* J. W. Hoard, Providence, Rhode Island.

Claim.—"The sectional 'ram' of the driver."

162. For an *Improvement in Explosive Shells;* William W. Hubbell, Philadelphia, Pennsylvania.

Claim.—"Combining or forming a series of oblique or propellor surfaces uniformly around the fuzee hole, on the extreme front face of the metal of an enlarged or thickened head of an elongated shell, with cylindrical body, and smooth semi-spherical hinder part."

163. For an *Improvement in Fan Rocking Chairs;* Konrad Kiefer, City of N. York.

Claim.—"1st, The fans when adjustable. 2d, The employment of a fan beneath the seat."

164. For an *Improvement in Fan Rocking Chairs;* Benjamin M. Lewy, Montgomery, Alabama.

Claim.—"A pendulum or self-acting driver, so applied to any rocking chair or cradle, or other rocking article of furniture, so that it will act by its inertia, to direct the fans."

165. For an *Improvement in Spring Platform for Railroad Cars;* Charles H. Lewis, Malden, Mass.

Claim.—"Connecting the guard to the box platform, by elastic band springs and a check chain, or its flexible equivalent, so as to enable the guard to adapt itself to the movement of the platform."

166. For an *Improved Piano-Forte Action;* N. Murphy Lowe, Boston, Mass.

Claim.—"The peculiar manner in which I have arranged the spiral springs upon the rod as applied between the hammer and the key."

167. For an *Improved Method of Cooling and Ventilating Rooms, &c.;* A. S. Lyman, City of New York.

Claim.—"The combination of a descending conduit or cold air flue, with a reservoir for containing cooling materials."

168. For an *Improved Carpenters' Bench;* J. W. Mahan, Lexington, Illinois.

Claim.—"The construction of a work-bench, together with the peculiar construction of the planes for jointing and facing."

169. For *Improved Machine for Sweeping Streets;* Joseph Miller, Boston, Mass.

Claim.—"Arranging the main driving shaft, its clutch lever and clutch in the upper and front part of the cart body, in order that the shaft may not only be unobstructed by the earth piled in the body, but have its clutch lever disposed within easy reach of the driver."

170. For an *Improvement in Gun Locks;* Edwin P. Monroe, Charlestown, Mass.

Claim.—"The pins, in combination with the coiled spring."

171. For an *Improvement in Wardrobe Bedsteads, combined with other Furniture;* Henry R. and James L. Plimpton, Westfield, Mass.

Claim.—"Constructing a bedstead with suitable parts attached thereto, in such a manner, that when not in use as a bedstead, it may be folded up and turned upright, and when in that position, by placing therewith a toilet table or wash-stand, or any other article of similar appearance, the whole apparently will form a secretary, book-case, wardrobe, cupboard, or any other similar piece of furniture."

172. For an *Improvement in Levers of Railroad Car Brakes;* Lucius Paige, Cavendish, Vermont.

Claim.—"The improved arrangement of levers and springs, and their application to the brakes of a railway carriage having swiveling truck frames—the same consisting in arranging two levers, so that they shall cross one another, and work on one common fulcrum, applying springs between said levers, and on opposite sides of the fulcrum, respectively, connecting both arms of the one, or the longer of the said levers, with the draft chain or rods of two windlasses, situated at opposite ends of the carriage body or platform, and respectively connecting the two arms of the other lever to the draft rod or chains of the brake levers."

173. For an *Improved Valve-motion for Oscillating Engines;* Horatio O. Perry, Buffalo, New York.

Claim.—"The valve motion as arranged in relation to, and in connexion with the loosely attached hollow throated and partially rotating valve."

174. For an *Improvement in Grain Separators;* Cyrus Roberts and John Cox, New Hope, Pennsylvania.

Claim.—"1st, The method of facilitating the separation of the grain from the straw, by means of diverging bars. 2d, Constructing the rear portion of the conveyor with a

solid rigid bottom, in such manner as to form a series of diverging channels, to spread the grain preparatory to delivering it to the winnower. 3d, The employment of shaking fingers, arranged and operated in such manner, that they will rise on the forward movement of the conveyor, and thus lift and shake the straw as it is thrown forward, in combination with the carrying bars, whereby certain advantages are obtained. 4th, The arrangement of shaking fingers, in a recess in the bottom of the conveyor, in such manner, that they can be alternately protruded above, and re-braced below the carriage bars, to shake the straw thoroughly, and at the same time not to interfere with its conveyance. 5th, The adjustable turning tail spout."

175. For an *Improved Field Fence;* J. B. Reyman, Salem, Indiana.

Claim.—"Forming a support for fences by means of angularly placed stakes, in combination with the mode of connecting them together and to the fence, by means of the wire, or its equivalent—the stakes and wire being so proportioned and arranged, that the act of driving the stakes into the ground shall tighten the wires and bind the whole together."

176. For *Improved Portable Field Fences;* James Rowe, Tampa Bay, Florida.

Claim.—"The construction of field fences, with shouldered laps perforated, and with upright battens on opposite sides of the string pieces."

177. For an *Improved Post Driver;* James M. Sampson, Waynesville, Illinois.

Claim.—"The segmental wheel, in combination with pinion and wheel, operating the drum upon the shaft."

178. For an *Improvement in Machines for Sizing Hat Bodies;* Albert Spencer, City of New York.

Claim.—"The application and use of the combination of the disk wheel and the rubber bed, when the bed receives a vibratory motion."

179. For an *Improved Clamp for Planking Ships;* Solon Staples, Bath, Maine.

Claim.—"The combination of the shank, arm, screw, and brace, with the rigid sliding tie."

180. For an *Improvement in Steam Boilers;* O. M. Stillman and Stephen Wilcox, Jr., Westerly, Rhode Island.

Claim.—"1st, Such arrangement of a series of vertical coils of different diameters, that when placed one within the other, spaces shall be left between—thereby forming flues, which allow the fire to act upon each of the said coils. 2d, The arrangement, in combination with the coils of a reservoir or boiler, placed within the inner coil, in such manner, that the greatest effect of the heat upon both will be obtained."

181. For an *Improvement in Syringe Bottles for Medicinal Agents;* John Stull, Philadelphia, Pennsylvania.

Claim.—"The combination and arrangement of a syringe and bottle, so that the latter shall serve as a protective case for the former, as well as a receptacle for the medicament to be used thereby."

182. For an *Improved Water Metre;* Andrew J. Sweeney, Wheeling, Virginia.

Claim.—"The combination of two cylinders and two pistons with one head, common to both, having the parts thereto attached, forming a cheap and effective metre, but with little liability to get out of order."

183. For an *Improved Cock for Steam, Water, &c.;* William Thomas, City of N. Y.

Claim.—"The position in which the method is employed or used to raise and lower the valve, viz: in having the screw thread cut upon the opposite end from the band wheel, and inner end of the valve stem, and a corresponding screw thread cut within the fixed screw nut, which is of sufficient depth as to allow the screw upon the stem, to work sufficiently far as to raise and lower the valve without disconnecting itself—whereby the whole arrangement can be better and more easily and substantially constructed, kept in order, and operated."

184. For an *Improvement in "Creepers" to Prevent Slipping on Ice, &c.;* William H. Towers, Philadelphia, Pennsylvania.

Claim.—"Forming the 'creeper' of three plates, having calkins or pins on their

lower surfaces, and bent at their outer ends, and jointed together at their inner ends, and in such relative position to the sides and back portion of the heel of the boot or shoe, for which they are designed, as will enable their outer ends to move eccentric with the curves of the said side and back portion, to secure the 'creeper' to the heel, and their security of attachment to be increased by the act of planting the foot of the wearer in walking."

185. For an *Improvement in Wrenches;* William Warwick, Pittsburgh, Penna.

Claim.—"Providing a shank with a recess, whose one side is toothed, and the other is smooth, in combination with a pawl placed into said recess, on the inside of the sliding jaw."

186. For an *Improvement in Cotton Seed Planters;* A. W. Washburn, Yazoo City, Mississippi.

Claim.—"1st, The peculiar shape and arrangement of the ridge former, and the adjustable channel former, by which their forward movement enables them, when suitably loaded, to unerringly form a perfectly smooth channeled ridge. Also, the combination of the inclined flanches with the inner periphery of the rotating seed dropper, when they are placed in such positions with relation to the discharging apertures, and have such a degree of inclination, that the said flanches prevent the seeds from being discharged out of the front (or descending) side of the said seed dropper, and cause the seeds to be freely discharged through the apertures in the rear (or ascending) side of said seed dropper, in view of the operator."

187. For an *Improved Butter Worker;* James H. Bennett, Bennington, Vermont.

Claim.—"The rotating bowl, in combination with the horizontal bar and spatula."

188. For a *Self-setting Rat-trap;* Samuel Beaumont, City of New York.

Claim.—"Attaching the door to the platform, and supporting said platform when elevated or inclined, by means of the swinging rods or arms, which are connected to the bait hook by the levers—and having springs attached, so that the platform, when the animal nibbles the bait, will have its supports drawn from underneath it, and be allowed to descend and close the door—the door and platform rising to their original position, when the animal passes off the platform into the compartment of the box."

189. For an *Improvement in Machines for Sawing Marble in Obelisk Form;* John A. Bailey, Detroit, Michigan.

Claim.—"The peculiar means employed for gradually moving the saws laterally or apart in the saw frame as said saw frame descends, viz: having the pulley attached to the centre of the right and left screw rod, and a chain passing around said pulley, and also around pulleys at the outer end of the pitman—the ends of the chain being attached to the upper and lower ends of the rod, to which the outer end of the pitman is attached, and on which it slides—motion being communicated from one screw rod to the other, by any known means."

190. For an *Improved Cultivating Plough;* Micajah Crenshaw, Springfield, Texas.

Claim.—"In combination with the series of cutting plates or disks, the series of reciprocating hoes, when the hoes are so arranged as to work in lines parallel with the cutters or disks, and so inclined downward and rearward, as to readily rise up over any obstructions without danger of clogging or choking."

191. For an *Improvement in Tools for Figuring Morocco;* Samuel Green, Lynn, Massachusetts.

Claim.—"Making figuring tools for leather of agate, glass, flint, or other similar silicious materials."

192. For a *Water Wheel;* John Haseltine, Goffstown, New Hampshire.

Claim.—"Making the water partitions of the floats radial—the second portion tangential, and the third and last portion to incline downwards from the shaft, and from the tangential portion, when the same or the several parts are constructed so that the water will act against the two first by propulsion, and upon the latter by its weight."

193. For an *Improvement in Machines for Sawing Marble in Obelisk Form;* Issachar A. Heald, Springfield, Mass.

Claim.—"The rock shafts, provided with arms having friction rollers at their ends,

the rock shafts being operated by the bar, having pins upon it, between which the roller on the pin works, said pins being attached to the reciprocating frame, for the purpose of raising and lowering the saws at each end of their stroke, so that sand may be admitted into the saw kerfs."

194. For an *Improved Mould for Earthen Vessels, Pots, &c.;* Philip Schrag, Washington, District of Columbia.

Claim.—"The combination of the mould, made in two separate parts; one for the sides, the other for the bottom of the vessels, with the lining of the same with india rubber, or any other suitable material, which is fastened on both parts of said mould."

195. For an *Improvement in Machines for Raking and Loading Hay;* D. H. Thompson, Fitchburgh, Mass.

Claim.—"The combination of levers with rakes."

196. For an *Improvement in Cotton Hillers;* A. W. Washburn, Yazoo City, Miss.

Claim.—"The lifting-up plates of my improved cotton hiller, when arranged and operating in conjunction with the governing plate and the hilling ploughs."

197. For an *Improvement in Cotton Scrapers;* A. W. Washburn, Yazoo City, Miss.

Claim.—"The bevel wheels, for supporting and guiding the machine, when they are arranged in conjunction with the side scrapers and the thinning-out cutter, or either of them."

198. For an *Improvement in Grain and Grass Harvesters;* Abner Whitely, Springfield, Ohio.

Claim.—"1st, Forming a joint by means of the plates and the lugs, of sufficient strength to support the ground wheel, and retain the driving cog wheel in gear, while running, without any other connexion with the main frame. 2d, Placing the driver's seat on the opposite end of the frame from the joint, in such a manner, that the driver's weight when seated on it, shall balance some portion of the frame work, &c., of the machine, and throw the weight thus made to balance each other on to the wheel, while the angle of the cutters and fingers is preserved. 3d, Bracing the finger piece, so as to make it self-supporting."

199. For an *Improved Printing Cylinder;* Justus Webster, Boston, and Samuel H. Folsom, Lowell, Mass.

Claim.—"The construction of the printing cylinder, consisting of metallic rings or disks, placed upon a shaft side by side; the longitudinal marks upon the paper that is printed by it, being produced by those disks having an unbroken perimeter, while the intermediate disks which produce the cross lines, have a broken or toothed surface; the combined disks being secured to the shaft, by a spline, with suitable collars and nuts at the ends."

200. For an *Improvement in Hand Corn Planters;* William Jenks, Alexandria, Va.

Claim.—"The 'bolsters' and distributor, in combination with the point."

201. For an *Improvement in Ash Sifters;* Charles Jones, Brooklyn, New York.

Claim.—"The use of the sieve, in combination with the double acting cranks and rods, for suspending the sieve, for the purpose and in the manner of arrangement of parts in any suitable ash box."

202. For an *Improvement in Scythe Fastenings;* Thomas C. Ball, Walpole, N. H., Assignor to Nathaniel Lamson, Shelborne, Mass.

Claim.—"The cylinder."

203. For an *Improvement in Harvester Cutters;* John H. Manny, Rockford, Illinois, Assignor to Peter H. Watson, Washington, D. C.

Claim.—"The reversible duplex sickle."

204. For an *Improvement in means for Regulating Variable Cut-offs for Steam Engines;* Henry S. Hopkins, Assignor to Hopkins, Hendrick & Peckham, Providence, Rhode Island.

Claim.—"Combining the reversed inclined plane with the main inclined plane of the regulator and valve mechanism. Also, combining the movable stop-block, with the two inclined planes."

205. For an *Improvement in Wrenches;* Halsey D. Walcott, Assignor to H. D. and M. E. Walcott, Pawtucket, Mass.

Claim.—"The core, pin, spring, and inclined bearing."

206. For an *Improvement in Horse Power;* Richard Hunt, Freeport, Illinois.

Claim.—"The combination of the central pivot and annular track, secured to the ground, with a master wheel fitted with a central eye, and an annular series of conical supporting wheels, whereby the usual supporting frame, to combine these several parts, is dispensed with, while the requisite steadiness of the master wheel is maintained."

207. For an *Improvement in Construction of Cisterns;* William D. Bartlett, Amesbury, Mass.; dated February 19, 1856.

Claim.—"A cistern."

Additional Improvements.

1. For an *Improvement in Excavating Machines;* J. J. Savage, City of New York; patent dated January 8, 1856, additional, March 11.

Claim.—"The adjustable brace, or its mechanical equivalent, in combination with the oscillating connecting arms, the combination being substantially as set forth. Also, the adjusting guide, or its mechanical equivalent, operated as described. Also, the tripping scoop, having a stationary back firmly bolted and braced to the scoop staff, which back forms a rest or shoulder for giving firm support to the scoop in its excavating operation, the scoop being affixed to the staff and operating as specified."

2. For an *Improvement in Mash Machines;* Adolph Hammer, Philadelphia, Penna.; patent dated January 9, 1855; additional, March 18.

Claim.—"The construction, application, and use of the inclined curved teeth."

3. For an *Improvement in Gas Burners;* Charles H. Johnson, Boston, Mass.; patent dated June 26, 1855; additional, March 18.

Claim.—"Extending up into the gas distributor and purifier, and among the wires of the latter, a cone having at its apex the inlet opening for the passage of gas into the purifier, the same serving to attain advantages as explained."

Re-Issues for March.

1. For an *Improvement in Spark Arresters;* David Matthew, Philadelphia, Penna.; patent dated Dec. 31, 1840; extended, Dec. 27, 1854; re-issue, March 4.

Claim.—"The combination of the cone and deflecting head with the wire gauze inside of the outer case, to deflect the steam, gases, and sparks downwards, retain the sparks, and allow the expanded steam and gases gently to escape through the gauze. Also, forming the chimney of sections with the base of the upper section enlarged beyond the diameter of the top of the section below it."

2. For an *Improvement in Grain and Grass Harvesters;* Abner Whitely, Springfield, Ohio; patent dated Feb. 5; re-issue, March 11.

Claim.—"1st, Changing the angle of the fingers and cutters of reaping and mowing machines, while the machine is in motion, and the finger piece resting on the ground as described. 2d, So constructing the machine, that the driver is enabled while the team is in motion, and the boxes of the master wheel shaft being rigidly connected with the main frame, to change the angle of the fingers and cutters without moving the finger piece from the ground."

3. For an *Improvement in Machinery for Splitting Match Splints;* Benona Howard, Assignee of Lewis Smith, City of New York; patent dated May 28, 1848; re-issue, March 11.

Claim.—"1st, The use of the arrangement of the four cutters, arranged and operating as set forth, in combination with the cutter frame or box, and also, the use of the cutters and cutter frame, arranged and operating as hereinbefore described, in combination with an adjustable cap or clearer plate, for the purpose of holding the blocks of wood while

under the action of the cutters as described. 2d, The jointed levers, or their equivalents, with or without springs at their back, for the purposes set forth, and their combination with the cutters and crank motion or other equivalent device for working or operating a crimper for crimping or matting the surface of the blocks of wood. 3d, The use of the crimping or compressing levers, in combination with the bed board, for crimping or matting the lower surface of the blocks as described. 4th, The use of the shafts and ratchet feed wheels, for the purpose of feeding the blocks through the machine, in combination with the adjustable cap or clearer plate and bed board, when used for the purpose of splitting blocks of wood."

4. For an *Improvement in Railroad Cars;* Bernard J. La Mothe, City of New York; patent dated April 4, 1854; re-issue, March 18.

Claim.—"The construction of the frames of railroad cars in the manner specified."

5. For an *Improvement in Machines for Making Nuts, Washers, &c.;* William Kenyon, Assignor to Haigh, Hartupee & Morrow, Steubenville, Ohio.

Claim.—"1st, The use of the die and die box, for severing the blank; the close die box, in combination with the dies and bracket, for pressing, and the punch for perforating the same during the pressure, the whole operating as herein described, for making nuts and washers at one operation. 2d, The manner herein described of so arranging the dies in relation to the punch that any excess of iron in the blank shall be forced into the path of the punch, thus securing the compression of the nut without risking the breaking of the machine."

6. For an *Improvement in the Machine for Forming the Web for Cloth of Wool, Hair, or other suitable substance;* Union Manufacturing Company, Assignees of The Legal Representatives of John Arnold, deceased, Norwalk, Conn.; patent dated July 15, 1849; extended from March 28, 1854; re-issue, March 18.

Claim.—"I do not claim as my invention the carding machines or any parts thereof, in common use; but I do claim the combined use of them, as herein described, for the purpose of crossing the fibres of the material of which cloth may be made, and the new machinery necessary to effect that object, particularly the comb carrier, the means described for severing the weft or web, and the fallers for placing the weft upon the warp, as described. Also, the depositing of the weft in separate sheets, edge to edge, upon the continuous sheet of warp."

7. For an *Improvement in Sewing Machines;* Sidney S. Turner, Westboro', Mass., Assignor to Elmer Townsend, Boston, Mass.; patent dated August 22, 1854; re-issue, March 25.

Claim.—"The arrangement of a hook or hook needle underneath, and so as to work up through the feeding bar, in combination with the arrangement of the presser above the feeding bar, and so as to press downwards towards it, such enabling me to obtain an important advantage in operating by the single chain stitch sewing machine. Also, arranging and operating the awl and the hook needle as described, that is, so that they may not only pierce in opposite directions the material to be sewed, but be withdrawn in opposite directions therefrom. Also, in combination with the mechanism for giving the vertical movements to the needle the slots—and the screw or pin—(or mechanical equivalents therefor,) for producing reciprocating semi-rotative movements of the needle, during the vertical movement of it."

8. For an *Improved Arrangement of means for working and stopping Chain Cables;* Thomas Brown, London, England; patent dated July 25, 1854; patented in England, April 20, 1847; re-issue, March 25.

Claim.—"The arrangement of the capstan, the removable rollers, and the sockets for said rollers, in such a manner, and having such relations to the hauze holes, chain locker, deck pipes, and under lifting stoppers, that a chain cable can be continuously hove in by means of said capstan and rollers, or be directly run out of the lockers without any previous overhauling. Also, the flaring out and radially flanched annular recess in the capstan, when it is given such a shape that in handling a chain cable, the series of cavities in the faces of said recess will so perfectly adapt themselves to the varying lengths and widths of the links of the cable that it can be safely and securely handled when the cable has only a partial turn around the capstan. Also, the arrangement of the within described, under lifting bow stoppers and after stoppers, by which more cable can gradually and controllably be given to a vessel while riding heavily at anchor."

9. For an *Improved Sawing Machine;* William P. Wood, Assignor to self and John S. Gallaher, Jr., and John S. Gallaher, Jr., Assignor to William P. Wood, Washington, D. C.; patent dated Feb. 26, 1856; re-issue, March 25.

Claim.—"Attaching saws to parallel rocking beams, by means of swivel bearings. Also, the reversible graduating scale gauge, in combination with the saw teeth."

DESIGNS FOR MARCH.

1. For a *Design for Parlor Stoves;* Samuel D. Vose, Albany, New York; patent dated March 4.

Claim.—"The combination of the various ornaments and mouldings on the several plates, the whole forming an ornamental design."

2. For a *Design for the Handles of Forks and Spoons;* Theodore Evans, City of New York; patent dated March 4.

Claim.—"The peculiar form and figure, as the design for either side of fork, spoon, ladle, and knife handles, the said articles being manufactured of metal of any known kind."

3. For a *Design for Elevated Oven Stoves;* Samuel W. Gibbs, Assignor to W. and J. Treadwell, Perry, and Norton, Albany, New York; patent dated March 18.

Claim.—"The combination and arrangement of ornamental figures and forms, represented in the accompanying drawings, forming together the ornamental design for the plates of a cooking stove."

LAW REPORTS OF PATENT CASES.

For the Journal of the Franklin Institute.

Winans vs. *New York and Harlem Railroad Company.*

An action at law was brought by Ross Winans against the New York and Harlem Railroad Company, for the infringement of Letters Patent, granted to Ross Winans, October 1, 1834, and extended for seven years by the Commissioner of Patents. The nature of the invention, claimed by Winans, will appear from the Letters Patent, to be not merely the running of cars upon eight wheels, but it is the manner of arranging and connecting the eight wheels which constitute the two bearing carriages with a railroad car, so as to cause the body of the car or carriage to pursue a more smooth, even, direct, and safe course, than it does as cars are ordinarily constructed, both over the curved and straight parts of the road. For this purpose he constructs two bearing carriages, each with four wheels, which are to sustain the body of the passenger or other car, by placing one of them at or near each end of it. The two wheels on either side of these carriages are placed very near to each other; the space between their flanches being no greater than is necessary to prevent their contact with each other.

Having thus connected two pairs of wheels together, he united them into a four-wheel bearing carriage, by means of their axles and a bolster of the proper length, extending across between the two pairs of wheels, from the centre of one spring to that of the other, and securely fastened to the tops of them. This bolster must be of sufficient strength to bear upon its centre a load of four or five tons. Upon this first bolster he

placed another of equal strength, and connected the two together by a centre-pin or bolt, passing down through them, and thus allowing them to swivel or turn upon each other in the manner of the front bolster of a common road wagon. He prefers making these bolsters of wrought or cast iron; wood, however, may be used. He prepares each of the bearing carriages in precisely the same way.

The body of the passenger or other car, he made of double the ordinary length of those which run on four wheels, and capable of carrying double their load.

The most important feature of his invention he considers to be the closeness of the fore and hind wheels of each bearing carriage, taken in connexion with the use of two bearing carriages, coupled as remotely from each other as can conveniently be done for the support of one body, for by the contiguity of the fore and hind wheels of each bearing carriage, while the two bearing carriages may be at any desired distance apart, the lateral friction from the rubbing of the flanches against the rails is most effectually avoided, whilst, at the same time, all the advantages attendant upon placing the axles of a four-wheeled car far apart, are thus obtained.

This case was tried before Judge Nelson and a Jury at New York, in November, 1855.

Judge Nelson's charge to the jury, contained a full examination of the law of facts of this important case; it is therefore given at length.

GENTLEMEN OF THE JURY: The first question in this case is—what is the thing, the machine, or instrument which the plaintiff claims to have invented? It is essential to comprehend this, in order to ascertain whether it is new—never before known, or in public use; and is also essential to enable you to determine whether the cars used by the defendants are a violation of the patent. It will be necessary, therefore, in the first instance, to turn your minds to the patent and the description of the improvement claimed, and which is there to be found. The description, I think I may say, is one of unusual clearness and precision for instruments of this character. We have had no difficulty ourself in ascertaining from it the improvement as claimed by the patentee, as it defines not only the arrangement and construction of the car—the running gear and the body—but also the principles governing the same, and upon which the improvement is founded. The patentee refers in the beginning to the numerous curvatures in the railroads of this country, the radius of which, in many instances, is but a few hundred feet, and to the friction arising between the flanches of the wheels and the rails, causing a loss of power, and destruction of both wheels and rails. He then refers to the high velocities on railroads by the modern improvements in locomotive engines, and the demand of public opinion—of the business interests of the country—for this description of speed, and also to the consideration, that certain things in the construction of both roads and cars become important which were not, and would not have been, at the old rates of speed. He observes that the great momentum of the load and intensity of the shocks and concussions are among the things to be noted and

provided for. The patentee then refers to the fact, that passenger and other cars, in general use upon railroads, have but four wheels, the axles of which are placed from 3½ to 5 feet apart, the distance being governed by the nature of the road upon which they are run, and other considerations. He then observes that, when the cars (meaning the four-wheeled cars) are constructed so that the axles retain their parallelism, and are at a considerable distance apart, there is, of necessity, a tendency in the flanches of the wheels to come in contact with the rails, especially on a curvature of a short radius, as the axles then vary more from the direction of the radii; and that, from this consideration, when taken alone, it would appear to be best to place the axles as near each other as possible, thus causing them to approach more nearly to the direction of the radii of the curves, and the planes of the wheels to be more in the line of the rails. But there are other considerations, he says, that must not be overlooked in the construction of the car, namely, the increased force of the shocks from obstructions at high velocities; and he observes that the greater the distance between the axles, while the length of the body remains the same, the less is the influence of these shocks and concussions. In consequence of this, he says, a compromise is most commonly made between the evils resulting from a considerable separation and a near approach, as, by the modes of construction now (meaning then) in use in respect to the four-wheeled cars, one of the advantages which he has referred to must be sacrificed to the other. The patentee then refers to the fact that the lateral curvatures of the roads, together with their irregularities, create these difficulties—are at the foundation of these difficulties. It becomes very important, therefore, he observes, both as regards comfort, safety, and economy, to devise a mode of combining the advantages derived from placing the axles a considerable distance apart, with those of allowing them to be situated near to each other.

Now, gentlemen, this is a result to which the patentee arrives, after his discussion of the various difficulties to be encountered in the construction of the car, and it may be said to be the leading idea—the general principle—the fundamental principle, if you please—embodied in the eight-wheel car, and which he has subsequently described. I will call your attention to it again, because it brings out the principle upon which the eight-wheel car has been constructed by the patentee. It tends, therefore, very much to develop the leading features—the controlling features of that construction. He says: It becomes very important, both as regards comfort, safety, and economy, to devise a mode of combining the advantages derived from placing the axles at a considerable distance apart, with those of allowing them to be situated near to each other. He then refers to the attempt to overcome these difficulties by the use of coned wheels, and to the partial remedy thereby, but points out the failure of the use of those alone, under high velocity, to get rid of the embarrassment.

The patentee then explains the object of his invention, which, among other things, is to make such an adjustment or arrangement of the wheels and axles, as shall cause the body of the car or carriage to pursue a more even, direct, and safe course than it does as cars are ordinarily constructed, both over the curved and straight parts of the road, by the *desidera-*

tum of combining the advantages of the near and distant coupling of the axles, and other means which he has described.

He then describes the arrangement and construction of his car, which I will not take up your time in reading. It has been read so often, and so frequently illustrated and exemplified in the progress of this trial, that I have no doubt you are familiar with it. It will be found upon the copy of the patent which I have, between folios 21 and 28. And then comes the claim. The patentee says, after describing the construction of his car:

"I do not claim as my invention the running of cars or carriages upon eight wheels, this having been previously done; not, however, in the manner or for the purposes herein described, but merely with a view of distributing the weight carried, more evenly upon a rail or other road, and for objects distinct in character from those which I have had in view, as herein before set forth. Nor have the wheels, when thus increased in number, been so arranged or connected with each other, either by design or accident, as to accomplish this purpose. What I claim, therefore, as my invention, and for which I ask a patent, is, the before described manner of arranging and connecting the eight wheels, which constitute the two bearing carriages, with a railroad car, so as to accomplish the end proposed by the means set forth, or by any others which are analogous and dependent upon the same principles."

The claim itself explains the improvement set up by the patentee. It is the arrangement and construction and adjustment of the eight-wheeled car, as described in his specification—*the car as a whole.* The patentee claims no right as inventor to any of the constitutent parts of the car—the wheels, the axles, the peculiar construction or framing of the running gear of the bearing carriages, the contrivances by which they are connected together, the springs, the bolsters, the turning of them upon the centre, or the swiveling of the trucks—nothing of this is claimed as new on the part of the patentee. This is plain from the terms of the claim, which is the construction and arrangement and adjustment of these various parts into a car as a whole, combining the advantages which he has set forth, as he claims.

Now, it is proper to observe, that this improvement, as claimed by the patentee, is made upon the existing four-wheel car then in general use, and which, as has appeared in the progress of this trial, is still in use in England, and, probably, upon the Continent, unless they have adopted our eight-wheel cars, some specimens of which I have understood have been sent to the Continent. It will, therefore, be proper and useful for you to examine this four-wheel car as then in general use, and the evidence in respect to it. Models have been introduced and exemplified, and no doubt you understand it. But you should inquire into this fact, in order to ascertain whether or not the difficulties described by the patentee existed upon curved roads at great velocity—I mean as respected this four-wheel car then in use upon roads with high velocity and with short curves—and whether or not the eight-wheel car, as arranged and constructed by the patentee, is an improvement upon it. This is one of the questions in the case for your consideration, and, as to this, you will probably not have much difficulty. From the time they were

first brought out in Baltimore—I mean the eight-wheel cars—it is admitted on all sides, that they have generally taken the place of the previous four-wheel car, and their use soon spread throughout the railroads of the United States, and, for aught that appears before us in this trial, the first construction and arrangement, and adaptation of those eight-wheel cars to the railroads of this country was in Baltimore, and they were constructed and arranged for the Baltimore and Ohio Railroad Company, and the Washington branch of it. It was offered, it is true, to be shown, on the part of the defendants, that one—that is, an eight-wheel car—was brought out in Massachusetts in 1838, but that fact, at that late day, affords no exception to the truth of the remark I have made: for the eight-wheel car, what is claimed by the patentee to be the perfected car, the car completed, and upon which the patent was founded, was made as early as the beginning of the winter—sometime in December, 1834—the Washington cars, some four years before the eight-wheel car in Massachusetts.

Now, gentlemen, if I have succeeded in explaining to you the improvement described in the plaintiff's patent, and claimed by him, upon these four-wheel cars, by the construction of an eight-wheel car, as I hope I have, the next question to which your attention must be called is this—whether or not this eight-wheel car, this improvement as thus described in the patent, and as first brought out in Baltimore—whether this was the improvement of the plaintiff. This is one of the material questions in the case, which, as you have already discovered, has been most seriously contested between the parties. After calling to your minds the construction given by the Court to the patent, and to what constitutes the improvement which is claimed to have been reduced to practical use—after you have ascertained and comprehended this improvement claimed by the plaintiff, and described in his patent—after this, which is a question of law, (I mean so far as the construction of the patent is concerned—) after you have ascertained what is claimed by the plaintiff as his improvement, the question whether or not he was the first inventor of it is a question of fact, which belongs to you to determine. The burden of the evidence—for the greater portion of the time, the long time which has been consumed in this trial—has been directed on both sides to the solution of this question. The patent of the plaintiff, given in evidence, and the extension of it for seven years, which has been given in evidence, together with the testimony of the experts introduced on the part of the plaintiff in the opening of the case, furnish *prima facie* evidence that the plaintiff was the first and original inventor of the improvement claimed, and of its utility; and, therefore, the burden of showing that he was not the first and original inventor, and of the inutility of the patent, rests upon the defendants. They are obliged to assume this position in that stage of the trial. Accordingly, they have gone into evidence at large for the purpose of satisfying you upon these points, and you have before you, first, the evidence from Baltimore, for the purpose of showing this—that, assuming the car described in the plaintiff's patent to be the improvement upon the four-wheel car, and that it was new and useful, yet the defendants insist upon this evidence, that the plaintiff was not the first inventor, but that somebody else was. They refer to the timber, the wood, and the trussel cars, and much evidence has

been given in respect to these cars. The plaintiff, on the contrary, insists that neither of them embodied his improvement, or that if any of them did, it was constructed after his invention, which it is claimed is carried back upon the evidence to the fall or beginning of the winter of 1830. Now, gentlemen, I am not going over this evidence on either side. It has been so amply and ably discussed by the learned counsel upon both sides, that I cannot doubt that you are familiar with every material portion of it. It will be for you to say, upon the evidence, whether or not the defendants have furnished evidence to satisfy you that the plaintiff was not the first and original inventor, but that somebody else was. They have that burden upon them. It will be for you to determine, upon the whole of the evidence, whether they have overcome the patent, and the evidence furnished in support of it.

Then another ground is taken, viz: that there is nothing new in the arrangement or construction of the car, as described in the patent, but that it was old, and before in public use; and they say that it is to be found in Chapman's patent and drawings, and also in Tredgold and Fairlamb—although, as to the two latter, they are not much relied upon—in the Quincy car, in the Allen locomotive, and in the Jervis locomotive. All these have been brought out in the progress of the trial, and amply examined and discussed, and I am persuaded that you are entirely familiar with all the evidence bearing upon this branch of the case. The question upon it will be, whether or not you find the improvement of the plaintiff—the improvement existing in the arrangement and construction of his eight-wheel car upon the four-wheel car—whether you find that improvement in any one or all of these patents or machines—not whether they have eight wheels and two trucks, free to swivel or rock—but the question is, whether the peculiar arrangement, adjustment and construction of the car—the wheels and trucks in relation to the road—claimed in the patent, and which I have endeavored to explain to you, on the principles which the patentee has developed—whether that embodiment thus found in the eight-wheel car is to be found in either of these structures to which you have been referred. That is the question.

Another ground of defence set up on the part of the defendants is, that Mr. Imlay is the inventor. You recollect his testimony, I have no doubt. It is claimed that he carries back the construction, or the idea, if not the construction, of the eight-wheel car, to 1829. It is, however, proper to say, in respect to this witness, that he spoke doubtingly as to time. He would not speak positively. It was a matter of memory with him. I noted his evidence particularly. He was uncertain as to time. But, whatever that time was, (and I refer to his interview with the Committee of the French Town Railroad,) he says he made a rough sketch of his idea of an eight-wheel car at this time, whatever time that may be, and that he made a contract with the road to build a car as he thinks, but which fell through in consequence of his partners not concurring with him; and then we hear no more of his connexion with an eight-wheel car until he removes from Baltimore to Philadelphia, in 1833, and brings out, I think, the "Victory," in 1834, or 1835, I am not certain which. I refer more particularly to the evidence of this witness, for the purpose of stating to you a principle of law. Now, the circumstance

that a person has had an idea of an improvement in his head, or has sketched it upon paper—has drawn it, and then gives it up—neglects it—does not, in judgment of law, constitute or have the effect to constitute him a first and original inventor. It is not the person who has only produced the idea, that is entitled to protection as an inventor, but the person who has embodied the idea into a practical machine, and reduced it to practical use. He who has first done that, is the inventor who is entitled to protection.

A kindred principle, also, it may be proper to state here, which is, that where a person engaged in producing some new and useful instrument or contrivance, and who has embodied it into a machine, and endeavored to reduce it to practice by experiments—if those trials fail—if he fail in success and abandon it, or give it up, that consideration affords no impediment to another person, who has taken up the same idea or class of ideas, and who has gone on perseveringly in his studies, trials, and experiments, until he has perfected the new idea, and brought it into practical and useful operation. He is the person—the meritorious inventor—who is entitled to the protection of the law.

Another ground of defence set up is, that the patentee allowed the public use of his improvement, of his eight-wheel car, upon the Baltimore and Ohio Railroad, before he made his application for a patent. Now, it is undoubtedly true, as the law stood at the time of this patent, in October, 1834, that the public use of the invention, with the consent of the patentee, or sale of it, prior to the time of his application for a patent, operated as a forfeiture—as a dedication to the public. This, however, means the use of the perfected invention—the invention complete. If the use be experimental, to ascertain the value, or the utility, or the success of the thing invented, by putting it into practice by trial, such use will not deprive the patentee of his right to the product of his genius. The plaintiff, therefore, in this case, had a right to use his cars on the Baltimore and Ohio Railroad, by way of trial and experiment, and to enter into stipulations with the Directors of the road for this purpose, without any forfeiture of his rights. He could not probably obtain the opportunity of trial which was essential to the perfection of his improvement without obtaining their consent, and, as I have already said, it is the use of the improvement after it has been completed and reduced to practical success, which operates as a forfeiture—as a dedication to the public—as a giving it up to the public.

Now, gentlemen, if upon consideration of these questions which I have submitted to you, you should come to the conclusion that this improvement is a useful one, and that the plaintiff is the first and original inventor of it, the next question for your consideration is, the question of infringement. If you are against the plaintiff upon either of the two first questions—of utility and originality—then, of course, this other question will not be reached.

Then, as to the infringement by the defendants' cars, the question is—do they embody the arrangement and construction of the plaintiff's car—in other words, the improvement in the plaintiff's specification? Improvements, as you have seen during the progress of this trial, have been made upon the eight-wheel car, since it was brought out and put in

operation. The swinging bolster is an instance, and there are also others that have been mentioned in the course of the trial. Now, the improvements thus made upon the eight-wheel car do not give any right to the thing improved. The plaintiff in this case would have had no right to use a four-wheel car if there had been a patent for it, because he had improved it by the eight-wheel car. So an improvement upon the eight-wheel car does not absorb, or give a right to the inventor of that improvement to use the thing improved. Therefore, the question still is whether or not you find in the defendants' organization and arrangement the organization and arrangement of the plaintiff's improved car. If you do, the additional improvements since made upon it do not disprove the infringement. It is a question of fact for you to determine. Having ascertained and comprehended what the improvement of the plaintiff is, as claimed in his patent, and which I have endeavored to explain to you in the beginning of this charge, you will apply that to the defendants' cars, and see whether it is embodied there. If it is not, then there is no infringement. If it is, there is an infringement.

Then, as to the question of damages. It is admitted by the counsel for the plaintiff that the amount stated in the declaration is $10,000. This suit was brought on the 16th of January, 1849, as stated. They claim damages for the years 1847 and 1848. It is in evidence that 24 eight-wheel passenger cars, 32 freight cars, and 8 baggage cars were used in 1847 by the defendants upon their road; and in 1848, 25 eight-wheel passenger cars, 35 freight cars, and 11 baggage cars. It is also in evidence, and it does not seem to be contradicted, that the patent fee for the right to use an eight-wheel passenger car, is worth $200 a car per annum for license, and that the freight cars and baggage cars would be worth $20 per annum. Taking this evidence, and there seems to be no contradiction about it, the damages claimed, upon the principle which I have stated, would exceed considerably $10,000. There is no doubt about that. But you are limited, and you cannot go beyond that sum.

These, gentlemen, are all the observations I think it is necessary to make to you.

I have prayers for instructions here, by the defendants' counsel, numbering, I believe, eighty, but the counsel must excuse me from going over them. I have given all the instructions, and all the principles of law that I deem necessary or useful in the submission of this case to you, and whatever may be found in these numerous prayers is beyond what I deem proper to trouble you with, for I regard them as not pertinent, nor relevant, and not material to comment upon.

The jury not being able to agree upon a verdict, were discharged.

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

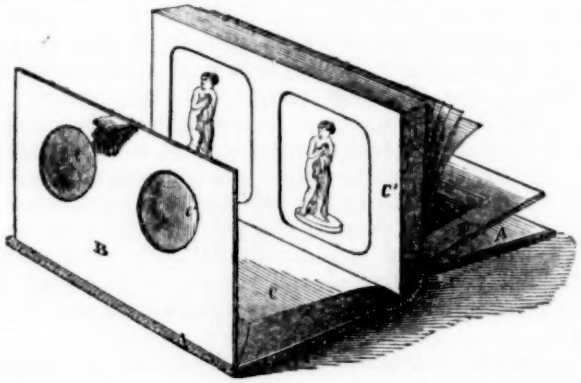
Mascher's Book Stereoscope.

The accompanying engraving, presents a view of an additional improvement in stereoscopes, for which letters patent were granted Feb-

ruary 18, 1856, to Mr. J. F. Mascher, of this City, the inventor of the "Stereoscopic Daguerreotype Case."

This stereoscope consists of a book, in which the stereoscopic photographic pictures are permanently bound. A supplementary lid, containing the two lenses, is attached to the outer edge of one of the lids of the book, and a "supplementary back," or perforated mat, is attached to the inner edge of the back of the book.

The object of the several parts will be more readily understood, by having reference to the engraving. A A, are the two lids (or shells) of the book. B, is the "supplementary flap," containing the two ordinary convex lenses *b b*, through which the two stereoscopic pictures are viewed, which latter are, by binocular vision, converted into one picture, possessing the well known characteristic relief. This flap is folded, when not in use, within the book, which latter, when closed, cannot be distinguished from an ordinary book. C C, are the leaves composing the book, upon which, are photographic or engraved pictures. These leaves are no thicker than ordinary printing paper of good quality, and a gross or more of such pictures may be bound in a book of ordinary size and thickness.



The book now before us, has blank leaves interposed between the pictures, which are designed for written descriptions of each picture. Printed descriptions would evidently answer a still better purpose.

A large number of blank leaves are bound in the back portion of the book, which are intended to be cut out for the purpose of allowing new pictures to be pasted in their stead, as they may be published from time to time; being, in this respect, similar to a scrap-book.

D, represents the perforated mat, furnished with gum elastic straps (not shown in the engraving), into which ordinary stereoscopic pictures, either Daguerreotype, albumen pictures upon glass, or the common paper pictures pasted upon card-boards, may be temporarily slid, for the purpose of being viewed through the aforesaid lenses, *b b*. This is a very simple arrangement, which enables the book to be used, not only as a stereoscopic book *per se*, but also as a common stereoscope. Indeed, the inventor has some of these books for sale, called by him "Skeleton Book

Stereoscopes," which he sells for 37½ cents each, in which the leaves are entirely absent. Again, stereoscopic or non-stereoscopic books can be constructed, in which the paper pictures are entirely substituted by a number of these supplementary backs, into which daguerreotype or other pictures are permanently fastened. In this manner a daguerreotype case (book) may be made capable of holding a dozen or more likenesses.

From the above dbrief escription, it is presumed that the arrangement of the book will be understood. We will now merely make a few remarks as to the objects to which the book may be applied.

By the employment of a peculiar lens, invented by the patentee, named by him the "Prismatic Lens," stereoscope books can be made of any size, even as large as a quarto-volume.

Again, by the employment of the principles embraced in the Stereoscopic Locket, illustrated upon page 215, Vol. xxix., of this *Journal*, (also by this patentee,) books can be made of the smallest size. They can be made so small that they can be carried in the pocket, or of a large and handsome size, suitable for an ornament for the centre-table.

They may be used as picture books exclusively, or works of biography, natural history, voyages and travels, mechanics, &c., &c., in which the ordinary wood-cuts are replaced by beautiful photographic stereoscopic pictures. Or, if the latter should be deemed too expensive, the stereoscopic pictures may be engraved in outline upon wood, which then, with the exception of the first cost of the engraving, will not cost more than the ordinary wood-cuts. That the latter may be done, is proved by the well known "Wheatstone diagrams." The patentee is now making a series of experiments, with a view of facilitating the engraving of stereoscopic pictures on wood. Photographic pictures are taken on wood, from which the engraving is directly executed in outline—in outline, because it is well known that to engrave in lights and shades, is one of the most difficult things to do, if not impossible; whereas, outline engravings are comparatively easy of execution. With these outline engravings, it is proposed to illustrate works on mechanics, &c., which it is believed will be not only perfectly feasible, but will be attended with only a small additional cost; and where is the machinist that does not know the advantage of having a *model* instead of a mere drawing, to look at? An ordinary drawing gives surface only, whereas a stereoscopic drawing gives surface and depth.

The book before us contains twelve beautiful interior and exterior views of the late French Crystal Palace, printed by the well known artists, *Richards & Betts*, as well as some portraits of eminent statesmen and actors. The book with pictures, all complete, will cost about $ 3·50, or less than what the pictures were sold for prior to his invention, or about the same price for which a good stereoscope without the pictures, could formerly be bought.

For any further information relative to a supply either of books, separate pictures, or the sale of patent rights for any particular publication, address the patentee, John F. Mascher, No. 408, north Second street, Philadelphia. M.

For the Journal of the Franklin Institute.

On Gas Furnaces. By CHARLES SCHINZ.

(Continued from page 274.)

In a first article, we have shown that one pound of anthracite is capable of producing 14,780 units of heat, and a temperature of 4956° Fah.; but at the same time are traced some of the reasons why this theoretical result is not attained in practice.

The quantity of heat as above estimated, in fact, may be produced, but only when double the amount of air is introduced to the fuel, and, as before stated, in that case, a large quantity of heat is lost.

In England and the United States, where fuel is cheap and plentiful, economy in its consumption is not an object of so great importance as in France and Germany, where, in most localities, the price of fuel is twice as great. Necessity, therefore, has in the latter two countries, called the attention of chemists and engineers to this point, and they have successively improved the construction of furnaces; indeed, to such a degree, that the theoretical effect obtainable from the fuel may be brought forth, not only from well prepared fuels, but also from inferior fuel of any kind.

The principle upon which this result is practically attained, is fully correct, and theoretically consists in the preliminary transformation of the fuel into gas, and burning the latter in a separate place, by the introduction of exactly the air required.

According to the quantity and the size of the fuel, a stratum of 2½ to 4 feet thickness, will produce from all the carbon contained in the fuel only carbonic oxide. The fuel composing the upper stratum of the fire, is sufficiently decomposed before it is consumed, to give off all the hydrogen, both combined with oxygen and carbon, and these compounds pass off with the carbonic oxide; carburet of hydrogen and carbonic oxide being burnt when they meet the supply of air.

If these gases are all burnt, and the fuel thus converted into carbonic acid and water, it is evident all the heat has been produced it was capable of, and if the two quantities of air, that which was used to form the gas, and that used to burn it, have been properly divided, the greatest intensity has also been obtained. To do this is, or was, the practical difficulty which existed in the use of gas furnaces.

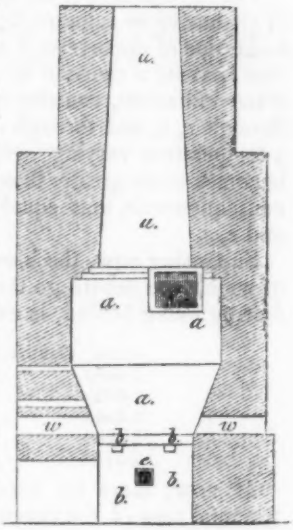
This difficulty would not exist, if both portions of air had to be introduced under the same pressure, but to produce a complete mixture of the air, and consequently complete combustion with the former, it is necessary to give them very different velocities. The difficulty is further increased, by the use of hot air instead of cold air to effect the combination of the gases, and this substitution, though not absolutely necessary, is yet highly commendable for different reasons.

I will proceed now to give a general idea of the construction and operation of a self-regulating gas furnace, for which I obtained a patent from the Government of the United States, dated December 4th, 1855, and which brings gas furnaces to a perfection hitherto unattainable.

Fig. 1, represents a vertical section of the gas furnace as seen from the front.

Fig. 2. A vertical section through the length, showing the generator, the heating furnace, and the contrivance for heating the air by the waste heat.

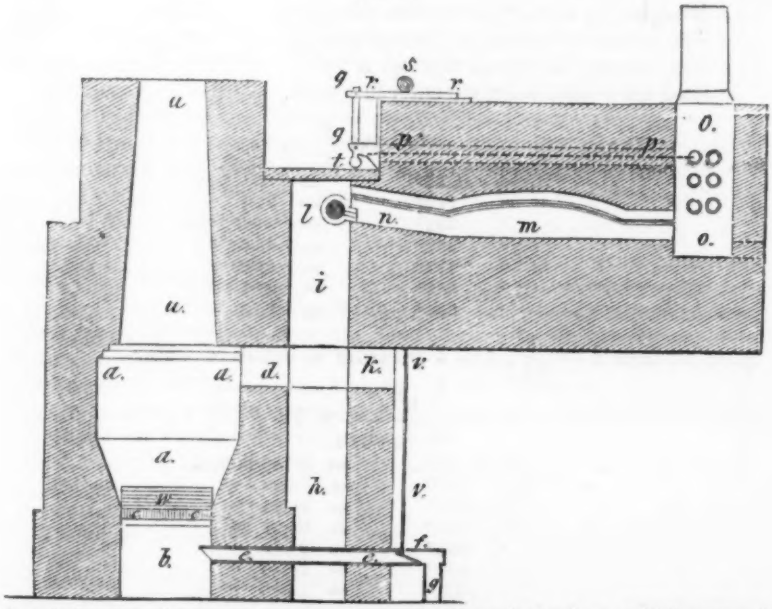
Fig. 1.



a, *a*, represents the fire place filled with fuel. *u*, *u*, the flue through which the fuel is introduced; it is closed above, and only open to feed; *c*, *c*, represents a grate. *b*, *b*, the ash pit. *e*, *e*, the air flue by which the cold air is introduced to the fuel. *g*, a pipe connecting *e*, *e*, with the blower. *d*, *d*, flue through which pass the gases generated in *a*, *a*. *h*, a pit collecting ashes and other impurities blown off with the gas. *k*, a short flue giving access for cleaning, &c. *i*, a perpendicular flue out of which the gas flows round the tuyeres *l* into the flue *n*. *m*, represents the heating furnace. *o*, *o*, the air heater; it consists of two sets of flues, each set has three flues, is connected with the main windpipe, and each brings the heated air by two separate pipes to the tuyeres *l*.

The tuyeres *l*, issue from one main pipe connected at both ends with

Fig. 2.



the air heater; the tuyeres properly are short conical tubes, which entered into the flue *n*, thus sending the heated air with velocity, and mix it with

the gas flowing from *i*. *w*, *w*, are flues for the purpose of cleaning the grate and tending the fire.

The tuyeres *l*, and the flue *e*, *e*, are therefore the points where the flow of air has to be regulated. Supposing now, the pressure of the air in the main pipe of the tuyeres *l*, and in the pipe *g*, to be the same, and the tuyeres *l* having a constant section, we may by the valve *f*, and by means of water indicators, contrive to introduce exactly the same quantities of air through *e*, *e*, and through *l*. But the air contained in *l*, being heated to a temperatnre varying between 300 and 600° Fah., the pressure then becomes much greater than in *g;* this produces a reaction upon *g*, and the consequence is, that equal volumes, but not equal weight, go through *l* and *e*, *e*.

Supposing now, the blower furnishes every second 2 cubic feet of air, of which one should go through *e*, *e*, and one through *l*. This one cubic foot by being heated, is expanded into

1·224	Cubic feet of the	temperature of	142° Fah.
1·448	"	"	252° "
1·672	"	"	362° "
1·896	"	"	472° "
2·120	"	"	582° "
2·344	"	"	692° "

If now, there are seven tuyeres issuing from *l*, each of one inch, the total area of the seven tuyeres is 5·4978 square inches; but, on account of the contraction the air undergoes, in passing through such tuyeres, this area is reduced to $5{\cdot}4978 \times 0{\cdot}94 = 5{\cdot}167932$ square inches $=$ 0·03588 square feet.

Designating now, this constant area by *s*.
The volume of air to go through it by *q*.
The velocity of the air through it by *v*.
And the pressure for effecting this by *h*,

$$\text{we have } \frac{q}{s} = v.$$

Hence *v* at 32°	=	27·9 feet.
" 142°	=	34·1 "
" 252°	=	40·3 "
" 362°	=	46·6 "
" 472°	=	52·8 "
" 582°	=	59·1 "
" 692°	=	65·3 "

$$\text{then } h = \frac{v^2}{64{\cdot}3} \text{ and } h' \text{ pressure in inches of water}$$

$$= \frac{v^2}{64{\cdot}3_{0{\cdot}0\frac{1}{0}1\frac{1}{3}}} \times 12$$

h' at 32°	=	0·188 inches.
" 142°	=	0·282 "
" 252°	=	0·394 "
" 362°	=	0·527 "
" 472°	=	0·677 "
" 582°	=	0·846 "
" 692°	=	1·035 "

These variations of pressure, of course, must be felt at *g* and *e*, *e*, and

if the area of e, e, is made to vary with the pressure, the consequence is, that a much greater weight goes through e, e, than through l.

What are now the areas to be given to e, e, by the valve f, for these pressures? Let s' be this variable area. q, is a constant quantity equal to one cubic foot. v in the function of h is the same as above, therefore, the area for each case is represented by the formula $\frac{q}{v} = s'$.

Hence when the temperature at l =	32°	s' = 5·168	square inches.
"	142°	s' = 4·222	"
"	252°	s' = 3·568	"
"	362°	s' = 3·091	"
"	472°	s' = 2·726	"
"	582°	s' = 2·438	"
"	692°	s' = 2·205	"

Supposing now, the square flue e, e, to measure inside four inches each way, the valve has to be lifted from the bottom,

2·508	inches to produce the area of	5·168	square inches.
2·945	" "	4·222	"
3·108	" "	3·568	"
3·227	" "	3·091	"
3·319	" "	2·726	"
3·391	" "	2·438	"
3·049	" "	2·205	"

Now, it is easy to lift the valve with accuracy, to the height required for each case, but the difficulty is, to know the expansion or the temperature of the air at l. A thermometer might perhaps indicate this, but, as the temperature varies very often, it would require the attendance of one man to regulate the valve. Hitherto, the quantity of cold air supplied to the fuel, has been regulated by the judgment of a workman, and this has been the practical difficulty in the use of gas furnaces.

A contrivance, therefore, which of itself regulates the supply of air, may be said to bring gas furnaces to perfection.

The self-regulator acts as follows: A metallic bar of such metal as expands largely when heated, as for instance, copper, is fixed in one of the pipes conducting the heated air to the tuyeres l; it is represented in Fig. 2 by the dotted line $p\,p$; it extends a little further than the pipe, and strikes against the lever $q\,q$, on which below a ball t is appended, giving it a tendency to remain in a perpendicular position. Connected with the lever $q\,q$, is the rack $r\,r$, and upon this is placed the cog-wheel s. When the bar $p\,p$ is expanded, as it does proportionally with the increase of temperature around it, the lever $q\,q$ is moved from its perpendicular position, motion is communicated to $r\,r$, and then to the wheel s. On the axle which supports the wheel s, are the eccentrics, and as s revolves, the bar $v\,v$ is raised, and with it the valve f.

Supposing the copper bar $p\,p$ to be ten feet long inside of the hot-air pipe, its expansion is

0·000	inches at	32°
0·126	"	142°
0·257	"	252°
0·393	"	362°
0·533	"	472°
0·678	"	582°
0·828	"	692°

As the lever is moved from its perpendicular, an angle, contained

between it and a line drawn to represent its original position, is formed, and the sine of this angle measures the expansion of the bar when the distance from the centre of the fulcrum is exactly one inch.

Seeking the angles corresponding to the different expansions, we have

Sine	0·126	=	7° 45″
"	0·257	=	10° 30″
"	0·393	=	14° 20″
"	0·533	=	20° 00
"	0·678	=	28° 30″
"	0·828	=	42° 20″

The wheel *s* is made of such a diameter, as to perform one revolution for the expansion of the copper bar *p p*, from 0 to 0·828 inches. If now, we divide the circle *s* into $42\frac{3}{8}\frac{0}{0}$ parts, it is apparent that each one of these parts corresponds to one degree of the angle made at the fulcrum by the lever with the perpendicular.

Having these data, the eccentric transferring the motion to the valve *f*, may be constructed as follows: divide the circumference of a circle of any diameter into $42\frac{3}{5}$ equal parts, take a point to start from, and at the distance of $7\frac{4}{8}\frac{5}{0}$ of these parts; from this point, draw a radius; at a distance of $10\frac{3}{8}\frac{0}{0}$ of these parts, from the same point draw another radius, and so on with the rest. On these radii mark off distances corresponding to the different heights to which the valve has to be raised, connect these marks by a curved line, and the result is the eccentric required.

It is evident that an eccentric so constructed, will cause the valve to rise or fall with the slightest variation of the temperature of the copper bar.

In the above calculations, we have supposed that equal weights of air had to be introduced through *e* and *l*. This is the case when the fuel used contains no free hydrogen, as, for instance, charcoal or coke. If, however, the fuel contains free hydrogen, allowance must be made, and a larger proportion of air be injected at *l*.

Every possible kind of fuel may be used successfully in these gas furnaces, though their construction varies with its nature and quality.

We remarked above, that though it was not absolutely necessary to burn the gases with air previously heated, yet it was commendable. We will examine this further. One pound of anthracite converted into gas yields 3747 units of heat, and the gas is composed of

Oxide of Carbon, ...	2·135 lbs.
Water (steam,)	0·219 "
Nitrogen, ...	4·737 "

The specific heat of these gases is respectively:

lbs.

$$\left.\begin{array}{l} 2{\cdot}135 \times 0{\cdot}2479 = 0{\cdot}529, \\ 0{\cdot}219 \times 0{\cdot}4750 = 0{\cdot}104, \\ 4{\cdot}737 \times 0{\cdot}2440 = 1{\cdot}156, \end{array}\right\} \quad 1{\cdot}789.$$

Hence the temperature that results from converting the fuel into gas

$$= \frac{3747}{1789} = 2094^\circ \text{ Fahrenheit.}$$

If, now, the gases are mixed with an equal quantity of cold air, viz:—

11·456 lbs., having the specific heat of $11{\cdot}456 \times 0{,}2377 = 2{\cdot}667$, the temperature of the mixture becomes

$$\frac{3747}{1789 \times 2667} = 841°$$ Fahrenheit, a temperature very

low indeed, and this temperature is still lessened, when, as is sometimes the case, the gases have to be conducted some distance to be burnt.

Another reason for the use of heated air is, that the intensity of the fire is greatly increased; for instance, the temperature obtained by the perfect combustion of anthracite, as shown in Table VII., = 4956° Fahr., of which 2094° Fahrenheit is obtained in the formation of the gases, and 2862° is produced by their combustion, and since the temperature of the blast at the tuyeres is 600°, we have the additional heat of 300° Fahrenheit. The intensity, therefore, = 2094° + 2862° + 300° = 5256° F.; a temperature which ranges amongst the highest ever observed, and one high enough for all metallurgic operations, as is apparent, when we consider that

Copper melts at	2012° Fahr.
Gold "	2282°
Cast Iron " from 2372° to . . .	2552°
Soft French Wrought Iron melts at . .	2732°
English Wrought Iron " . . .	2912° *

In metallurgic operations, an intense heat is the most economical for two reasons: 1st, The time; it requires less time to bring the body to be heated to the required temperature; and, 2nd, because the transmission of heat is nearly proportional to the square of the difference between the heating and the heated bodies. Too much importance can scarcely be given to this last fact, and it is as unfortunate as true, that many persons are entirely ignorant of it. The self-regulating gas furnace, from the intensity of the heat it produces, may be safely recommended for all smelting processes, distillation of zinc, heating and puddling of iron, cobalt, and the smelting of glass. It removes many difficulties, hitherto inseparable from all fires and furnaces; 1st, and most important, it, of itself, introduces the exact amount of air necessary for the combustion of the gases, thus complying with the chief requirement of the theory for producing the greatest amount of heat from fuel; 2d, the draft is constant; 3d, the draft is entirely within he operator's control, and 4th, it possesses many little mechanical contrivances, not given in the drawing, viz: the use or disuse of a grate as required, and in the latter case, the removing of the ashes without trouble, the feeding

* These figures appear to me the most reliable. It is amusing to observe how authors have copied from one another in representing the temperatures obtainable in furnaces; thus introducing many blunders into science. So we read,

Temperature of a china furnace	from 11,000 to 12,000° Fahrenheit.	Knopp.
" " Gas furnace,	9,388° "	
Melting point of cast iron,	17,977° "	

Whereas, at the present day, it has been accurately demonstrated, and is a settled fact, that no fire, produced by atmospheric air, can yield a heat more intense than 5000 and some hundred degrees.

of the fuel without exposure to the flame, the comparative absence of dust and ashes in the heating flue, &c., &c.

The sphere of usefulness of gas furnaces is gradually enlarging; they have been successfully applied in Germany, to the evaporating pans used in the manufacture of common salt. They are as yet considered inapplicable to steam boilers, distillation of liquors, and, indeed, in all cases where intensity of heat is not desirable; but it may yet be found possible in some such cases, to use them to advantage by interposing some non-conductor of heat, as brick, to the most intense part of the flame.

For the Journal of the Franklin Institute.

Particulars of the Steamer Edinburgh.

Hull and Machinery built by Tod & M'Gregor, Glasgow. Intended service, New York to Glasgow.

HULL.—

Length on deck from fore part of stem to after part of stern post above the spar deck,	300 feet 6 inches.
Breadth of beam at midship section,	39 " 10 "
Depth of hold,	19 "
" to spar deck,	26 " 6 "
Draft of water at load line,	17 " 9 "
" " below pressure and revolutions,	17 "
Tonnage, register,	2197.
Contents of bunkers in tons of coal,	650.
Masts and rig—ship.	

ENGINES.—Steeple.

Diameter of cylinders,	76 inches.
Length of stroke,	6 feet
Maximum pressure of steam in pounds,	12.
Cut-off at	$\frac{3}{4}$.
Maximum revolutions per minute,	17.

BOILERS.—Four—horizontal return tubular.

Number of furnaces,	3 in each boiler.
Description of coal,	Bituminous.
Combustion,	Natural draft.
Consumption of coal per day of 24 hours,	45 tons.

PROPELLER.

Diameter of screw,	14 feet.
Pitch "	20 "
Number of blades,	3.
Geared,	3 to 1.

Remarks.—Floors doubled and shaped ⅂, *molded* 6 ins., *sided* $\frac{1}{2}$ in., flanch 3 ins. Distance of frames apart, *at centres*, 18 ins. Has three water tight bulkheads. Is double riveted throughout with $\frac{3}{4}$ rivets $3\frac{1}{2}$ inches apart.

C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer James A. Requa.

Hull built by Harlan & Hollingsworth, Wilmington, Delaware. Intended service, New Grenada.

HULL.—

Length on deck,	214 feet.	
" " between perpendiculars,	210 "	
Breadth of beam,	32 "	
Depth of hold,	7 "	
" " to spar deck,	7 "	
Load draft,	2 "	6 inches.
Tonnage,	450.	
Area of immersed section at load draft,	70 "	

ENGINES.—Inclined direct non-condensing.

Diameter of cylinder,		24 inches.
Length of stroke,	8 feet.	
Weight of engines and wheels,	210,000 lbs.	

BOILERS.—Five—Cylindrical—flued.

Length of boilers,	35 feet.	
Breadth "	3 "	6 inches.
Weight of " without water,	120,000 lbs.	
Load on safety valve, per square inch,	140 lbs.	
Number of furnaces,	5.	
Breadth of "	(?) 18 "	6 "
Length of grate bars,	6 "	
Number of flues,	10.	
Internal diameter of flues,		15 "
Length of flues,	34 "	
Heating surface,	2400 sq. ft.	
Diameter of chimney,	5 "	
Height "	50 "	9 "

PADDLE WHEELS.—

Diameter over boards,	26 feet.	
Length of "	8 "	
Depth "		15 inches.
Number "	19.	

Remarks.—Frames, shape L, 3 ins. × 3 ins. × $\frac{3}{8}$ in. and 24 ins. apart. Number of strakes of plates from keel to gunwales, 11. Thickness of plates $\frac{3}{8}$-$\frac{5}{16}$ and $\frac{1}{4}$ in. Number of bulkheads, 3. Diameter of rivets, $\frac{5}{8}$ths. Distance apart, 2 ins.; single riveted. Depth of keel, 4 ins. Independent steam, fire, and bilge pump, 1. Has 11 athwartship frames, and 8 side keelsons 12 ins. deep. C. H. H.

For the Journal of the Franklin Institute.

"*Improved Double-Action Force Pump.*" By ERSKINE HAZARD.

I was much surprised, on reading the article at page 32, of the *Journal of the Franklin Institute*, for January last, that none of the Committee on Publications gave our countryman, Jacob Perkins, Esq., the credit of inventing the double-stroke force pump, claimed by Robert Aytoun. It is precisely his single barrel fire and garden engine pump, which was

manufactured by him in great numbers in this City, some thirty-five years ago; and afterwards by his successors, Merrick & Agnew. In those engines, an external cylinder, surrounding, and communicating with the top of the pump barrel, by numerous holes, formed the "bent pipe," leading to the air vessel. If I am not mistaken, I have, some years since, seen the same principle applied to common lifting pumps at Carbondale, a thick pump-rod acting like a plunger, in keeping up a continuous discharge.

On Working Steam Expansively in Marine Engines. By Mr. E. ALLEN.*

(Continued from page 256.)

In the foregoing paper, the object of the author has been merely to collect a few particulars of the different classes of vessels, and to give a rough approximation to the effects which would be produced by a certain saving in fuel, even did no alternative exist but that of increasing the size and weight of the engines.

There does not appear to be much doubt about a *saving in fuel*, even of 40 *per cent.*, being made by *expansive working*, considering what is now the general average consumption.

If the present ordinary consumption be taken at 4½ lbs. of coal per indicated horse-power, a saving of 40 per cent. would reduce it to 2¾ lbs. per horse-power, and this quantity will appear ample, when it is considered that many land engines are working with 2¼ lbs. per indicated horse-power.

The pressure of steam assumed in the foregoing calculations of the saving of coal, where different sized engines are employed, has been only 20 lbs. above the atmosphere. A very much larger saving would, however, result, if steam of a higher pressure were used. The principle upon which the engines are supposed to be altered, is that of increasing the diameter of an ordinary cylinder, presuming the stroke to remain the same.

As the interests of marine engineers and steam-ship builders must, in the long run, be identical with those of the merchants or companies employing them, it is clearly of the utmost importance to endeavor by every means to economize fuel. Little, however, can be hoped for so long as the merchant determinately refuses to pay for that economy in some shape or other. It is not to be expected that engineers will supply larger engines than custom necessitates, and for which they obtain no additional payment; nor will they exercise their talents to economize in that direction which appears least appreciated.

Considerable competition has for a long time existed amongst engineers for the purpose of reducing the space occupied by engines, but this has been done without reference to the question of economy in total space of machinery and coal, or without reference to economy in consumption of fuel.

This competition has been, nevertheless, productive of much good,

* From the Lond. Mechanics' Mag., Aug., 1855.

as reduction in weight and space occupied by engines is of the utmost importance, other things remaining the same.

It is believed, however, that when the subject is better understood by merchants than it appears to be at the present time, they will no longer refuse to purchase the economy when offered to them.

Were the Government now to throw open a contract, where *economy in fuel* was the object sought, in the same manner as they did some years ago, when *economy in space and weight* were the objects, we might look for the same or greater benefits than then resulted from so advisable a plan.

The author has now to show in what manner he believes nearly all the advantages enumerated in the foregoing Tables can be obtained, by a peculiarly constructed engine of his invention, adapted for the *expansive use of steam*, without those disadvantages which have doubtless prevented the more general adoption of the principle of expansion in marine engines, viz: the increased size, weight, and cost of the engines.

The degree of expansion to which it is necessary to work, in order to obtain great economy, would seem to require an arrangement of engines different from the ordinary one, inasmuch as the great variation of pressure from the beginning to the end of the stroke, would cause considerable irregularity in the working of an engine where no fly-wheel can be employed. Added to this objection, there is also another of equal importance—the necessity of making all parts of the engine (where a single cylinder of large capacity is used for expansive working), strong enough to resist the greatest strain to which they are subject, namely, that at the commencement of the stroke, the weight and cost of engine rising also in a corresponding degree with its strength. In order, therefore, to overcome these objections, and adapt it for marine purposes, it seems necessary that an engine should be arranged on the following principles:

1st. That the steam on its first entrance should act upon a comparatively small area.

2d. That it should finally expand to a considerable extent, the limit being determined by the friction of the machinery and the pressure of uncondensed vapor in the condenser.

3d. That the variation in total pressure from the beginning to the end of the stroke should be as small as possible for any given expansion.

4th. That the work done by the in and out strokes (that is, of a horizontal screw engine) should be equal, or as nearly so as possible.

5th. That the horizontal or floor space occupied, should be as small as possible—the height not being of great importance, if within say 6 or 8 feet.

6th. That the strain upon all parts of the engine should be as nearly uniform as possible, and not concentrated at any portion of the stroke.

7th. That the steam, from its entrance to its exit, should work against a vacuum, if possible.

The arrangements shown in the accompanying engravings, meet to a considerable extent, the above conditions. They are all upon the *double* expansive principle, and therefore may be said to work with both high and low pressure steam.

Figs. 1 and 2, show an arrangement in which the high pressure steam enters into the upper part of the cylinder, and presses upon the *annular*

Fig. 1.

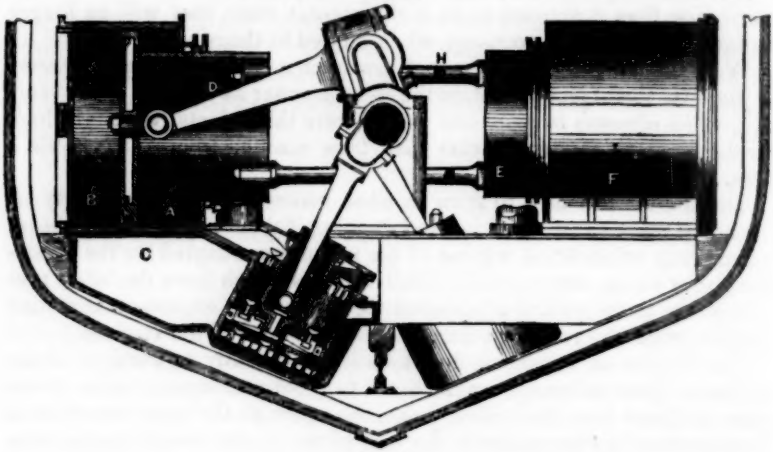
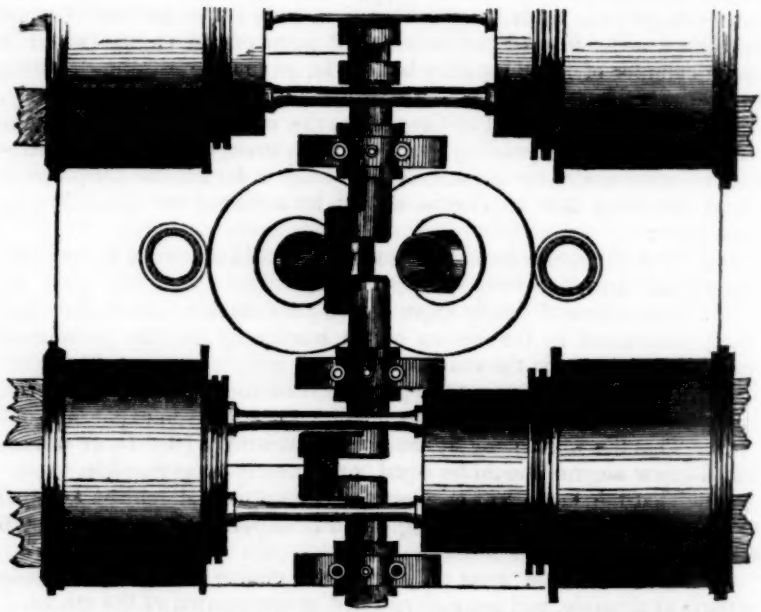


Fig. 2.



space A A, round the trunk—this being comparatively a small surface—it is cut off at $\frac{1}{4}$ or $\frac{1}{2}$ of the stroke, according to circumstances, and then is passed to the lower end B of the cylinder, in which it is expanded to the extent required, this being in the ratio of the annular space to the whole area of cylinder. During the time the high pressure steam is acting on the annular space A A, the lower part B of the same cylinder is

open to the condenser C, and while the steam is expanding on the lower part of the cylinder, on an area equal to that of the trunk D, a vacuum is maintained in the bottom of the *opposite* cylinder F, and so admits of the greatest degree of expansion. The trunks D E, of the two opposite cylinders, being firmly connected together by the rods H H, causes the pistons of both cylinders to move simultaneously, and the gross power exerted in each direction is made up of the pressure of the high-pressure steam in one cylinder, and the expanding steam in the other or opposite cylinder. The trunks are for the purpose of shortening up the engines as much as possible.

The main features in this arrangement are, first, that the atmospheric pressure on the outer end of the trunk is counterbalanced, which, if not done, would prevent the steam being worked so expansively, as the pressure of the atmosphere on the trunk would be added to the pressure of the high-pressure steam which is not required, and would have to be balanced by the expanding steam, which (in order to maintain an effective moving power) could not then be expanded to the same extent; and, secondly, that the high-pressure steam acts only upon a comparatively small area.

Fig. 3.

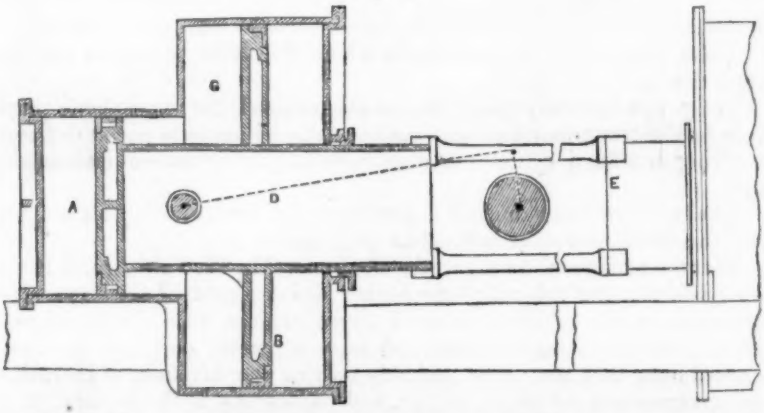
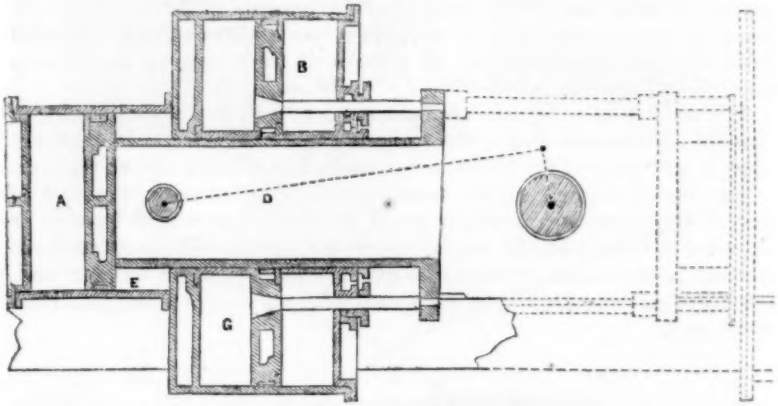


Fig. 3, shows an arrangement by which an objection to a large trunk could be overcome. This plan is much the same as Sims' arrangement, only having a trunk D, attached to the pistons for economizing space, a vacuum is here maintained *constantly* in the space G G, between the two pistons; the high-pressure steam acting on the bottom of the small piston at A, and afterwards expanding in the annular space B B. The trunks D E, being small in this case, the same necessity would not exist for combining opposite trunks together, though in the event of the power being large and four cylinders employed, an evident advantage would follow.

Fig. 4, shows an arrangement by which an engine, on the above plan, could be made double-acting, that is, having high-pressure steam admitted on *both* sides of the small piston at A and E E alternately, and using *both* sides of the large piston B B and G G alternately for expansion. This is done in the way shown—the cylinders being distinct, and the trunk D,

being encased as it were by a tube through the large cylinder—thus avoiding any internal stuffing box. In this arrangement the large piston is an *annular* one, and the junction between the two pistons is made *externally* by two or more piston-rods F F, being attached to the large piston and to the trunk.

Fig. 4.



There are several other forms in which the same principles may be carried out.

In fig. 1, where only two cylinders are required, the atmospheric pressure on the trunk may be counterbalanced by an opposite *piston* or *trunk* working in a fixed cylinder or condenser having a vacuum maintained in it.

The modifications would all depend upon the particular objects sought, and the conditions to be fulfilled in each case.

After the reading of the paper, the Chairman (Mr. W. Fairbairn, F.R.S.) observed that the subject of the further development of the expansive principle, in the different forms of steam engines, had become one of great practical importance, and had been at present only very partially carried out; they were most probably only on the threshold of extensive improvements in the steam engine, and particularly in the application of the expansive principle, combined with higher pressures than had been hitherto generally used. The degree of expansion of the steam was seldom carried at present beyond about three times, but he thought it might be carried up before long to ten times, or even higher, the important economy of which had been so ably shown in the paper read by Mr. Allen. To carry this out thoroughly, so as to obtain the full commercial benefit of the economy that was practicable, a considerably higher pressure of steam in the boilers would be requisite than was at present generally made use of; the pressure in the marine and land condensing engines had been already increased very generally from the old limit of 6 lbs. or 7 lbs. above the atmosphere to about 20 lbs. per square inch; and in the Cornish engines to 40 lbs. or 45 lbs.; but it did not appear impossible that this might be ultimately increased even to 100 lbs., or 120 lbs., as was constantly used in locomotive engines.

(To be Continued.)

For the Journal of the Franklin Institute.

United States Mail Steamer Fulton. By ERASTUS W. SMITH, Resident Engineer to the "New York and Havre Steam Ship Company."

(WITH A PLATE.)

Vessel built by Smith & Dimon, under the superintendence of Captain William Skiddy. Engines by the Morgan Iron Works. George Quintard, Proprietor.

DIMENSIONS.—

Length on deck,		290	feet.
Breadth of beam,		42	" 4 inches.
" over all,		65	" 6 "
Depth of hold,		31	" 6 "
Tonnage, custom house,	2300.		
" carpenter's measurement,	3000.		
Diameter of cylinders,		65	"
Length of stroke,		10	"
Diameter of paddle wheels,		31	"
Length of paddles,		9	"
Number of " in each wheel,	28		
Width of "		18	"
Shafts of wrought iron.			
Diameter of crank journal,		18¾	"

BOILERS.—Two of iron, with vertical brass tubes, one boiler forward of the engines, the other aft.

Length of boiler,	12	feet.
Width "	30	"
Height " exclusive of steam chimney,	14	"
" " inclusive " "	26	"
" of smoke chimney above " "	40	"
Diameter of "	6	"
Total amount of fire and heating surface,	9100	square feet.
" " grate surface,	343	"
Number of furnaces in each boiler,	7.	
Draft "	Natural.	
Length of grates,	7	feet.
Description of coal.—Outward passage,	Anthracite.	
Homeward "	Bituminous.	
Maximum pressure of steam to square inch,	25	pounds.

Remarks.—The *Fulton* has three decks, the upper or spar deck being "flush" and surrounded with galvanized iron netting. Pilot houses, rooms for the cooking galleys, butcher, baker, and pastry cook; a few officers' rooms, entrance to cabins and the machinery, are the only joiner work incumbrance on the spar deck.

Forward, is Captain Skiddy's (Brown's patent) anchor capstan, bitts and deck stoppers, by which thirty-two feet of cable are hove in per minute. They are a great improvement over the old windlass arrangement, and merit the especial attention of the inspectors for the Underwriters. The next important feature forward, is the pilot or steering house, where the helmsman can see as well, and as soon, any danger ahead, as the forward watch; and shift the helm immediately, without waiting for the word to be passed aft. There is, in addition, a second or reserve steering wheel, in the usual place aft.

There are three double acting hand fire engines on deck, with 600 feet of fire hose. There are also provided, eight life-boats, six of iron,

(Francis's patent,) two of wood. Every boat is furnished with water, provisions, sails, oars, &c., and on sailing, the passengers are numbered for each boat. Every boat is officered and manned, the officer's rank being painted on her; and there are regular station bills throughout the ship, appointing every one of the crew to their places in case of fire or collision.

Below the spar deck, on the main or "berth deck," we have the dining saloon, sleeping rooms, ventilating and lighting galleries, skylights, polished tables, beautifully veneered and polished portheads, ladies' saloon and boudoir, pantries, steam table, second cabin dining saloon, with sleeping rooms forward, all on the same general plan and style as those of the steamer *Arago*.

The *Fulton* can accommodate 300 passengers, carry 800 tons of coal and 700 tons of freight, with a draft of water of 17 feet 6 inches. The frames at bottom are of oak, with long filling-in, floor timbers of oak, making the floor solid the entire length of ship. Frames at keel, moulded 17 inches; sided 16 inches; distance between centres 32 inches. Frames from floor heads to clamps on spar deck, strengthened by diagonal iron truss work, composed of bars $4\frac{1}{2}\times\frac{3}{4}$-inches, cross laid at angles of 45°, riveted together at their intersections with each other, and each bar bolted to every frame it crosses. The bottom is first planked in the usual way, which being thoroughly caulked, she is double planked up to water line with white pine $3\frac{1}{2}$ inches thick, and fastened with composition bolts through every timber. There are eleven tiers of keelsons on the floor of the ship extending nearly to the ends. The ceiling and clamps are all square fastened, that is, two bolts in each plank through every timber, and the planks bolted vertically to each other edgewise between every frame. There are four water-tight bulkheads athwartship, and two fore and aft, making a box 105×18 feet, enclosing the engines and boilers. The longitudinal bulkheads are of double plank and timber, stiffened with cross-laid and riveted diagonal iron straps, similar to frames of ship, and add to her great longitudinal strength. The space between the latter bulkheads and sides of ship, are appropriated to coal, and the ports through which it is taken into fire-rooms are fitted with slide gates, which can be shut tight in case of accident causing the compartment to fill with water.

Engines.—Two inclined oscillating engines, one cylinder forward, the other aft, making with each other an angle of 90°, and connecting upon one crank pin, which connects the paddle wheel cranks, there being no "centre shaft" in the arrangement; by which is saved the centre-shaft, two centre-shaft cranks, one crank-pin, two engine frames, and two plumber-blocks. The channel plates do not, as in most other forms of marine engines, form any part of the foundation or frame work of the engine, and, together with the air pumps, feed pumps, bilge pumps, injection and bilge valves, are under the cranks, and all open to the view of the engineer, and accessible when the engines are in motion. The air-pump beams are of wrought iron worked by links connecting with crank-pin.

The engine frame, is a combination of cast and wrought iron, in the form of the letter **A**, being in section of one of the trunks between plumber-block and cylinder-trunnion, 18 inches wide by 3 feet deep. The sides

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NEW YORK AND HAVRE STEAM SHIP COS.

U. S. MAIL STEAMER FULTON.

2300 TONS.

and bottom of trunk are of plate iron $\frac{3}{8}$-inch thick, riveted with $\frac{3}{4}$-inch rivets in three and four rows. Cylinder trunnions are $24\frac{1}{2}$ inches diameter. The head of cylinder is fitted with a guide-yoke, extending beyond the stuffing box, and embracing the piston rod. This is a new and valuable arrangement, as it takes the pressure of the piston rod in oscillating the cylinder, and saves the stuffing box from any unusual wear.

The cylinder valves are of the usual balance poppet variety. The arrangement for operating them and effecting a cut-off, is new and ingenious. It is the invention of Mr. Hermann Winters, of the Morgan Iron Works. There are no rock shafts in the arrangement, but there is to each cylinder, three revolving shafts, by the motions of which, with their appendages, the lifting and lowering of the steam valves is accomplished by two distinct motions—the lowering being the quickest. The same shaft also gives to the exhaust valve, a greater average opening than is obtained by the common rock shafts. The point of cutting-off is variable and adjustable while the engine is in motion. A combination of this arrangement admits of the engine being reversed instantly, and worked back full power, with the eccentric "hooked on," without shifting it; a feature of very great importance. The boilers are of the variety known among engineers as the "Martin boiler;" and for which, Daniel B. Martin, Esq., Engineer in Chief to the U. S. Navy, has a patent. The tubes are of brass, without seam; being drawn from brass ingots by the American Tube Co., Boston. The water passes through the tubes, and the fire around them, the same as in the vertical tubular boilers, which have for five years performed efficiently and economically, on the New York and Liverpool U. S. Mail Steam Ships, where they were first successfully introduced on ocean steamers, through the enterprise and liberality of E. K. Collins, Esq. In the Collins's boilers, the tubes are located directly behind, and adjoining the furnace, and take the "direct action" of the flame. In the *Fulton's* boilers, the tube-box is located *over* the furnace, and take the "return action" of the flame. The latter plan has been adopted for all the new Government Steam Frigates, and the new Collins's Steamer *Adriatic*.

The engine department is provided with two of Worthington's steam fire engines, and bilge pumps, of extra large size, the steam cylinders being 16 inches diameter, and made expressly for this ship. They are operated for port use, by a small auxiliary boiler, but at sea, are connected with the main boilers, and in case of fire or leakage, would perform very efficient service.

The engines are surrounded with three ornamental iron galleries, affording great convenience for inspecting every part of the engine. The whole was arranged by Mr. Myers Coryell, Constructing Engineer for the Morgan Iron Works, under the superintendence of the Company's Resident Engineer. No attempt has been made to secure extraordinary speed, which costs so many sacrifices of power, fuel, and freight capacity. The best day's run on the first voyage, was 288 miles, when the pressure of steam was 20 lbs. to the square inch, and consumption of coal, 77,300 lbs. Pirsson's fresh water condensers are to be added on the third voyage, when more steam will be produced from an equal combustion of fuel.

The Company merit success for their patronage of new things, without which no improvement or progress could be made; and we are indebted to the confidence and liberality of Mortimer Livingston, Esq., the agent, for an opportunity to make the first application of the simple and effective oscillating engine to transatlantic navigation.

He is also the first to apply the athwartship and longitudinal bulkheads, in steam ships constructed of wood.

The accompanying illustration, exhibits the style of rig, and is a correct representation of the ship.

For the Journal of the Franklin Institute.

Particulars of the Steamer Lewiston.

Hull built by John Englis, New York. Machinery by Neptune Iron Works, New York. Intended service, Boston to Portland.

HULL.—

Length on deck from fore part of stem to after part of stern-post above the spar deck,	246 feet.	
Breadth of beam at midship section,	33 "	
Depth of hold to spar deck,	12 "	3 inches.
Draft of water at load line,	8 "	
Tonnage, custom house, 1000.		
Area of immersed midship section at load line,	228 sq. feet.	
Masts and rig—schooner.		

ENGINES.—Vertical beam.

Diameter of cylinder,		52 inches.
Length of stroke,	11 feet.	
Cut-off $\frac{1}{2}$.		

BOILERS.—One—Return flued.

Length of boilers,	29 feet.		
Breadth "	furnace,	13 "	6 inches.
	shell,	11 "	
Height " exclusive of steam chimney,	11 "	5 "	
Number of furnaces, 3.			
Breadth of furnaces,	3 "	$4\frac{1}{2}$ "	
Length of grate bars,	7 "	6 "	
Number of flues,	lower, 10.		
	upper, 6.		
Internal diameter of upper flues,	1 "	5 "	
Heating surface, (fire and flues,)	1837 sq. feet.		
Diameter of smoke pipe,	5 feet.		
Height " "	32 "		
Description of coal, Anthracite.			
Combustion, Blast.			

PADDLE WHEELS.—

Diameter,	31 feet.	
Length of blades,	7 "	8 inches.
Depth "		28 "
Number " 27.		

Remarks.—Floor timber, at throats, *molded* 15 ins., *sided* 14 ins. Distance of frames apart *at centres* 24 ins. Frame strapped with diagonal and double laid iron straps 4 by $\frac{3}{4}$ in., sponsons under guards fore and aft. Cabins on spar deck and promenade deck. Forecastle enclosed.

C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer Etna.

Hull built by Laird & Co., Greenock. Intended service, Havre to New York.

HULL.—

Length on deck,		304 feet.	8 inches.
Breadth of beam, (molded,)		37 "	
Depth of hold,		20 "	2 "
" " to spar deck,		28 "	2 "
Tonnage, { hull,	1222. } 2223.		
{ engine room,	1001. }		

Masts—3.—Barque rigged.—

ENGINES.—Over-head beam.

Diameter of cylinder,		76¾ inches.
Length of stroke,	5 feet.	
Cut-off at	¼.	
Average revolutions,	27.	
Gearing,	2½ to 1.	

BOILERS.—Four—tubular.

Load on safety valve per square inch,	14 lbs.
Number of furnaces,	14.
Consumption of coal per day,	45 tons.

PROPELLER.—

Diameter of screw,	14 feet	6 inches.
Pitch of screw,	23 "	

Remarks.—Frames, shape L 5½ ins. × ⅝ in. and 15 ins. apart. Thickness of plates, ⅝ to 1 inch. Number of bulkheads, 5. Diameter of rivets, ¾. Distance apart, 3⅛; single riveted. Independent steam, fire, and bilge pumps, 2. C. H. H.

For the Journal of the Franklin Institute.

Memoir :—On a new method of applying the power of Steam, and of Condensing the same after it has been so applied; the former is designated The "Differential" system of Steam Power, and the latter, The Hot Water system of Condensation. By THOMAS PROSSER, Civ. Eng., New York.

There are two methods of applying steam as a motor, the *positive* and the *negative;* to which I purpose to add a third, and to call it the *differential* method.

In the first or "Positive" method, the steam drives the atmosphere before it, and then loses itself entirely in it, without leaving a particle of the heat by which it had been created, to be returned into the boiler; all is lost after it has left the cylinder, and this constitutes the high pressure non-condensing engine.

In the second or "Negative" method, the principal use of the steam is to negative or remove the pressure of the atmosphere; the pressure of the steam may be insufficient to overcome the friction of the engine,

and, therefore, the air-pump is the real motor and acts as a *tug;* this is the low-pressure air pump condensing engine.

Many persons appear to suppose, that the simple injection of cold water into the condenser, sets and keeps the engine in motion at a very small expense, and that the air pump refrigerator is not much of a tax upon the power of the steam; but good authority shows that it is an enormous one. Dr. Ernst Alban says,* that "out of 17 lbs. total pressure, only about 7 lbs. are made available for useful effect."

Nothing, indeed, is necessary, but the presence of a desiccator to make the air pump condenser a complete freezing machine. Dr. Haycraft has some observations † on this subject in connexion with surcharged steam, which are important, as showing how the cold is produced and reproduced in the air pump condenser.

By the "Negative" method of using steam, the feed water is taken in at a higher temperature, so as to save from 4 to 5 per cent. of the fuel necessary to convert it into steam; this is really a very small affair, only about enough to work the air pump itself, while the great refrigerator is causing vaporization,‡ and consequently producing cold to an enormous extent. But let that pass, while I proceed to show some of the advantages of high pressure steam.

There is more heat in the same weight of steam at a high pressure, than there is at a lower one; nevertheless, its density is not increased in the same ratio as its tension.§ For example, steam at 230° Fah. has an elasticity of 42·3374″, and a total heat of 1152° F., while steam at 356° F. has an elasticity of 297·1013,″ and a total heat of 1190·52° F.; so that, while the total heat has increased 1·03343 times, the elasticity has increased 7·01747 times, but the density‖ has increased only 5·93184 times, clearly showing that, whatever saving there may be in heating the feed water by the condensation of the steam, it is far inferior to the gain by

* The High Pressure Steam Engine investigated by Dr. Ernst Alban, translated by William Pole, London, 1847. John Weale, p. 58.

† Repertory of Arts, (3 S.) vol. xii, p. 25, (1831,) and London Mec. Mag. vol. liii, p. 288 and 302, (1850,) wherein the Doctor very handsomely acknowledges some former errors, but makes a promise, which I am sorry to say, has not been entirely fulfilled. The engine was exhibited in 1851, but the results are not known to me.

‡ Vaporization in a vacuum takes place at 68° F. according to Ginelin, (Cavendish translation, vol i, p. 271,) so that the water in the air pump condenser is boiling away and carrying off the heat just the same as that in the boiler, but not quite so usefully.

§ Ginelin, vol i, p. 259, gives the temperature 163° C., elasticity 3·571 met., actual density 443·32, density corresponding to the elasticity 714·2, showing a difference of 270·88, which is a gain of 61 per cent., from which, however, must be deducted the amount of heat, which, according to the text, exists in high pressure steam more than in that of a low pressure, and that leaves a gain of 48$\frac{3}{4}$ per cent.

"The higher the temperature, the greater is the difference; hence the advantage of high pressure steam engines."—*Despretz.*

‖ The authority for the temperature, pressure, and other physical properties of steam is M. V. Regnault in the 21st vol. (1847,) of the Mémoires de l'Academié Royale des Sciences de l'Institut de France, a translation of which may be found in the *Journal of the Franklin Institute*, Vols. xv, xvi and xvii, Third Series. There is also a very meagre one by the Cavendish Society, (1848.) concluding with the ninth memoir, (there are ten in the original,) and an error in the last column which gives the total "heat above 32° F." instead of above 0° F. The density of steam I have calculated on the supposition that 490·463° represents the number of degrees necessary to double the pressure of air from 32°, and that steam obeys the same law. If, therefore, p=pressure and t=temperature, we have

$$\text{the relative densities} = d = \frac{p}{t + 490\,463}.$$

the application of high pressure steam, for while the former is only from 4 to 5 per cent., that of the latter is

$$14\tfrac{1}{2} \text{ per cent.} = \frac{7{\cdot}01747}{1{\cdot}03343 \times 5{\cdot}93184}.$$

I do not purpose to go further into this investigation now, as I have sufficient data for my present purpose.

The points now arrived at, are these, that there is a saving by using high pressure steam on account of its elasticity increasing faster than the sum of its density and total heat, and that when such steam has a pressure of about 297″ of mercury, the gain amounts to $14\frac{1}{2}$ per cent.; also, that the small saving effected by pumping the feed water into the boiler of an air pump condensing engine at a somewhat increased temperature, is fully counteracted by the power necessary to work the air pump.

If, therefore, in our calculations, we omit for the present, all considerations of the additional heat given to the feed water, and also, the loss caused by excessive condensation in the cylinder of the air pump condensing engine, we may readily obtain a general expression, which will represent the economic value of that method of applying steam at any pressure, and which, at the same time, is equally applicable to the "Positive" and to the "Differential" methods.

The Differential method consists simply in using steam under two different pressures, the one in the boiler and the other in the condenser.

In the case of steam at 356°, I would have the laboring power = 255″ (= 297″—42″) and of course the exhaust steam at 230°, which will heat the feed water to 221°, so that 970° (= 1191—221) must be restored in the boiler to the feed water pumped into it from the condenser.

In the "Positive" method of using the same steam, the laboring power will be = 267″ (= 297″—30″) because of the removal of the 42″ of *lively* back steam pressure, and the substitution of 30″ of *dead* atmosphere therefor.

Now, the decreased power caused by using the steam in the manner which I have proposed is from 1· to ·955056 $\left(= \frac{255''}{267''}\right)$ but as it is also the cause of the increased temperature of the feed water from 60° to 221°, the advantage of which is as 1·17629 to 1·

$$\left(= \frac{1141}{970} = \frac{1191 - 50}{1191 - 221}\right)$$

The sum of these two values is 1·12342 (= ·955056 × 1·17629) which shows an increased economy of $12\frac{1}{3}$ per cent. by using the steam "Differentially" instead of Positively, and as the latter has an advantage over the "Negative" of $14\frac{1}{2}$ per cent., the "Differential" method has, of course, the advantage of a gain of 28·602 per cent., which is the sum of the two values. But even this, $28\frac{3}{5}$ per cent., is quite below the real saving in fuel, for in addition thereto, the boiler is always clean and free from scale, which is another source of economy in fuel, as well as a great saving of time and hard usage, which other boilers are subjected to in scaling, so that there can be little doubt, as to the saving in fuel alone being fully 30 per cent. in land engines, and more than 60 per cent. in sea-going steamers, for I have excellent authority for stating, that the saving by using fresh instead of sea water is 25 per cent.

But, to return to the question of a general expression, which shall represent the three methods of using steam, I suggest, that $\varepsilon = \frac{p-p'}{(t-t')\,d}$ where p is the pressure of the steam from the boiler upon one side of the piston, p' the pressure of the exhaust steam on the other side thereof, t, the total heat in the steam p, above 0° C., t' the temperature of the feed water, and d, the relative densities of the steam p. Surely no test more severe than this, can be desired against the "Differential" method. I shall use the Centigrade scale of temperatures, as being more convenient than the Fahrenheit, and in all respects conform as nearly as is practically desirable to the authority I have referred to.

The relative density of steam, therefore, will be represented by $d = \frac{p}{t+272{\cdot}479}$, which is of the same value as the equation given in Note ‖, p. 344 the change in the constant number being necessary on account of the adoption of the Centigrade, instead of the Fahr. scale of temperatures. The economic value of the fuel will then be represented as before stated by $\varepsilon = \frac{p-p'}{(t-t')\,d}$, but for greater perspicuity, I shall insert the whole of the numerals in the equation, and adopting the "Negative" method of using steam as the initial of value, working with steam of 1·415 atmospheres pressure, and 110° C. of temperature, with a total heat of 640° C., the condenser being at ·155 atmospheres pressure, and the feed water at 10° C., * of temperature, we have,

lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
6	110	Equation No. 1. "Negative." $1. = \varepsilon = \frac{1{\cdot}415-{\cdot}155}{(640-10),\ 1{\cdot}415 \over 110+272{\cdot}479}$
75	160	Equation No. 2. "Positive." † $1{\cdot}03715\ \varepsilon = \frac{6{\cdot}120-1{\cdot}}{(655{\cdot}3-10),\ 6{\cdot}120 \over 160+272{\cdot}479}$
55	150	Equation No. 3. "Differential." $\cdot 99929\ \varepsilon = \frac{4{\cdot}712-1{\cdot}415}{(652{\cdot}2-105),\ 4{\cdot}712 \over 150+272{\cdot}479}$

* The feed water, as before stated, is taken at the natural temperature, the same as in the "Positive" method, for the reason that at whatever higher temperature it may be, the advantage is absorbed in working the air pump.

† I have taken the nearest decade of temperature in the Table at the end of the ninth "Memoire," to avoid unnecessary trouble in the calculations. The slight variations in the results are of no importance whatever.

These coefficients of ε, all represent about equal values, and the table gives the necessary pressures above the atmosphere for the steam to be used in each case, to work with equal economy of fuel, at 6 lbs. for the "Negative," 75 lbs. for the "Positive," and 55 lbs. for the "Differential" methods; a result which few probably would have anticipated under the circumstances, for, not a single advantage is given to the "Differential" method, while every disadvantage has been omitted that might tell against the "Negative," as well as against the "Positive" ones.

If we allow about 15 per cent. of waste by condensation in the cylinder of the air pump condensing engine, making the initial of economic value $= \cdot 85\varepsilon$, we shall find, that, to work with equal economy of fuel, both the "Positive" and the "Differential" methods will require the steam to be 38 lbs., when on the "Negative" method it is 6 lbs. above the atmosphere.

I will now show the economic value of each method under a pressure of 131 lbs. to the square inch, above the atmosphere.

lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
131	180	Equation No. 4. "Negative." $1 \cdot 26484\ \varepsilon = \dfrac{9 \cdot 929 - \cdot 155}{(661 \cdot 4 - 10),\ \dfrac{9 \cdot 929}{180 + 272 \cdot 479}}$
131	180	Equation No. 5. "Positive." $1 \cdot 1559\ \varepsilon = \dfrac{9 \cdot 929 - 1 \cdot}{(661 \cdot 4 - 10),\ \dfrac{9 \cdot 929}{180 + 272 \cdot 479}}$
131	180	Equation No. 6. "Differential." $1 \cdot 2899\ \varepsilon = \dfrac{9 \cdot 929 - 1 \cdot 415}{(661 \cdot 4 - 105),\ \dfrac{9 \cdot 929}{180 + 272 \cdot 479}}$

It thus appears, that, if the "Negative" method is practicable, there will be a gain of 26½ per cent. in using steam at 180° C., instead of 110°.

In like manner the "Positive" method shows an advantage of 15½ per cent., but in both cases the gain results from the increased pressure.

In the "Differential" method, on the contrary, the gain of 29 per cent. results from the increased temperature, both of the working steam, and of the feed water, the latter being the chief feature of the system; the gain by the former is 15½ and by the latter about 13½ per cent.

High-pressure steam with the "Negative" method is out of the question, for the innate disadvantages become too glaring; the enormous proportions of the air pump and condenser must be increased, and the condensation in the cylinder will be increased in a still higher ratio, on account of the increased difference in temperature between the exhaust and the working steam.

No one will, I trust, deny that thus far I have shown the "Differential" system to be far superior at every point to the "Positive" method, and fully equal at moderate pressure even to the "Negative" one, while it is more than equal to it at high pressures, if, indeed, that be practicable at all on the "Negative" system. And now, what shall we allow for the loss of power by condensation in the cylinder of the air pump condenser, and other causes? And, what shall we allow of useful effect on the "Differential" plan? Dr. Ernst Alban (p. 85,) says, that the former returns but 41·2 per cent. of useful effect, while the ordinary high pressure engine returns 75 per cent.; others make the difference still greater; but I am content to take 50 per cent. of useful effect as resulting from the "Negative" method, and 73¼ per cent. for the "Positive" one. The proportions of useful effects are, therefore,

as 1 to 1·465 $\left(=\frac{73{\cdot}25}{50}\right)$ showing a gain of 46½ per cent. as due to the economy of high pressure steam, superadded to the loss by condensation in the cylinder of the low pressure air pump condensing engines. To this we must add the gain of 13½ per cent., which results from the "Differential" method of using the steam, and which is an entirely distinct source of gain, and consists in feeding the water into the boiler at a higher temperature. Therefore, 1·60 (=1·465+13½) represents the economic value of the "Differential" method, when 1 represents that of the "Negative" one. In other words, the useful effect of the fuel is 60 per cent. in favor of the "Differential" method of using the steam, even in the ordinary land engine. For sea-going steamers, the saving of fuel is 25 per cent. more, making a gain of 100 per cent. If, then, these calculations are correct (and their simplicity almost forbids the possibility of error), there can be no manner of doubt that the Atlantic may be crossed by steamers adopting the "Differential" system, with less than half the fuel now usually consumed. A transatlantic steamer of the largest class, will consume 1600 tons of coal per voyage out and home, on the average of the year round. This coal really costs, to get it on board, and to get it off again, together with the useful space occupied by it and the boiler, and the whole apparatus for its consumption, not less than $20* per ton, or $32,000 per double voyage. The half of this expenditure I propose to save, simply by consuming but half the quantity of fuel to produce the same effect; and on the half so consumed, I propose to save half the space occupied by the boiler, and also half the cost thereof (as they will last double the time), making $2·50 per ton on 800 tons, or $2000 more to be added to the half of $32,000, showing thereby, a saving of $18,000 on every voyage hence to Liverpool and back.

As much depends upon showing that there is a great loss by the use of the air pump, which causes condensation in the cylinder, I may be

* Cost of one ton of coal, with labor to put on board, to consume it when on board, and then throw the ashes overboard, . $ 7
Value of space occupied, . . 8
Space occupied by boiler to consume coal, . . 2
Cost of so much boiler, . . . 3
$ 20

permitted to return to that point again. Not that the "Differential" system is less the *true one* even without that proof, but, because that alone is necessary to put the matter beyond dispute or conjecture. If any power can be gained by the use of the air pump, nay, if it is not the cause of an absolute loss of power, it is quite different to all other mechanical action, which is ever reduced in power by a transfer to a secondary object, just as the steam engine may and has been used to pump up the water to operate a water-wheel, but, of course, with the loss of power due to the friction of both combined. When the steam has forced the piston to the end of the stroke, and is suddenly condensed, the same operation is going on upon the metallic surfaces open to the condenser, to wit, the cylinder and the piston on one side or the other, so that when the steam is again let in, these cooled surfaces must necessarily condense a large portion of it, by many estimated at fully one-half. By working expansively, however, as soon as the steam is cut off, the reduced pressure causes the water in the cylinder to re-boil, and the surplus heat contained in the steam when of higher pressure takes it up, and hence the indicator gives no record of the fact. If the commonly received notion is correct, we get a mechanical something for nothing, and are in the neighborhood of perpetual motion.

Dr. Ure employed the vacuum formed by the condensation of steam in a separate vessel, to produce attenuation and consequently refrigeration of the air under a receiver, and thus dispensed with all mechanical power to pump out the air; but, it never entered his head that it cost nothing to do it, nothing in fuel. The waste by air pump condensation is pretty well ascertained by the gain in using surcharged steam, for that gain can be but the absence of a portion of the waste referred to, just as a very bad boiler may be proved to be a paragon of perfection when compared with another infinitely worse.

The anomaly of reducing the temperature of the water resulting from the condensation of the steam, for the purpose of having to heat it again, under the impression that the removal of the pressure of the atmosphere can by any possibility be an equivalent therefor, is quite contrary to all analogy and sound argument. Need I adduce any other proof against the value of the "Negative" method, than the fact, that, no one thinks of using high pressure steam in such a manner, when there can be no objection to doing so if the principle is right? The already enormous proportions of the air pump and condenser must be vastly increased, the condensation in the cylinder will be increased also, in proportion to the increased difference of temperature between the working and the exhaust steam.

By the "Differential" method, the cylinder is instantly exposed to a temperature of 105° C. when opened to the condenser, being a difference of 75° C. (180—105), while the air pump condenser is usually about 46° C., showing a difference of 64° C. (110°—46°), although the pressure of the steam is but *one-seventh*. In Hall's surface condenser, the difference was not less than 94° C. (110°—16°), and so of other surface condensers to be equally as good as his was; however, the condensation in the cylinder is considerably increased thereby.

Nor must we pass by the amount of condensing water used, which in

the surface condenser of Hall, amounted to 300 lbs., to condense 5lbs. of steam per minute with 58 feet of metallic surface;* *i. e.*, 60 lbs. of condensing water to one by weight of steam condensed, which is nearly double the amount used by Watt,† and *twelve times* as much as is required on the "Differential" plan.

That the condensation in the cylinder is very great, no one has ever denied—of its amount, however, I have only represented the opinions of others, and do not rely on them, but shall content myself‡ in ascribing it to no other cause than the simple difference of temperature between the working and the exhaust steam. We shall thus get rid of all the *mystery* which attaches to the case. From my own experience of the working of the "Differential" system, I am satisfied that the amount of condensation in the cylinder does not exceed two per cent., if indeed, it is as much. This will give 12 per cent. for condensation in the cylinder of an injection air pump condenser, and nearly 18 per cent. for Hall's air pump surface condenser, which is most decidedly the best of its class. The "Differential" method has in the above calculation, seven times the pressure of steam, and $\frac{7}{8}$ the difference of temperature of the injection "Negative" method, and hence, the latter must condense about 6 times as much as the former, while the air pump surface condenser must condense nearly 9 times as much. It is well known that Hall's condenser did not economize fuel to the extent that was calculated upon; and I would ask, may not this statement account for it? Adhering to my modification of Dr. Ernst Alban's statement, that 50 per cent. can be obtained of effective power from the condensing air pump engine, while 73¼ per cent. is obtainable from the non-condensing one, we have a loss of power,

By the different methods of	"Negative." by Injection.	"Negative." by Surface.	"Differential."
Condensation in the cylinder,	12	18	2
Friction and all other causes,	38	38	24¾
Loss per cent.,	50	56	26¾
Effective working power,	50	44	73¼
	100.	100.	100.

That the "friction and all other causes" on the "Negative" plan, will be much more than I have allowed, as compared with the "Differential" one, I believe will be readily granted, when it is considered that the dia-

* Tredgold on the Steam Engine (1838), p. 371.

† Farey on the Steam Engine, p. 593.

‡ I do not mean by this to disparage any of the authorities whom I have quoted, but only to avoid the possibility of error in my calculations, by taking nothing for granted which is not thoroughly recognised; and, therefore, I apply to this case the rule laid down and universally admitted, that, the rate of cooling is directly as the difference of temperature. This rule, however, only applies to dry gaseous bodies; where moisture is present in the cooling medium, the effect is greatly increased, and this in fact is the case under consideration, but for the reasons stated, I abandon this source of advantage to the "Differential" method, in these calculations, to avoid abstruseness, as I can well afford to do, where the gain is so great without it.

meter of the piston and the stroke also must be doubled to obtain the same power. I think this method of accounting for a well known fact, is much better than introducing any imaginary ones, however ingenuous, into the argument, as some have done in regard to surcharging, and other methods of using steam, which can effect nothing more than the prevention of condensation in the cylinder. But the views which I have suggested, do not in the least detract from the advantages claimed for the "Differential" system, but I do not wish to undertake the defence of anything except the "Differential" system.

In my method of condensation, I use three annular surface condensers, each in its own cistern. The bottom one distils the water to make up for waste. The cistern first receives the *cold condensing water*, which becomes somewhat warmed therein, and then enters the *main condenser cistern*, where it is made to boil before leaving it as *waste;* but a portion of it, forming vapor, goes over and down into the *distilling condenser*, and thus becomes condensed and is collected, as is also that from the *main condenser*, by means of a pipe from the bottom of each, passing through the bottoms of their respective cisterns to pumps, which force the water through the sides of the *cistern* above into the *heater condenser*, and from thence into the boiler, having become heated by the exhaust steam, which first enters at the bottom of this upper or *heater condenser cistern*, and after having performed its office of heating the feed water, goes into the *main condenser*, and the water resulting from its condensation is collected as before stated. The *bottom condenser* then, (to recapitulate,) receives the vapor from the *main cistern* to make up for waste and other purposes, the *main condenser* receives the exhaust steam and the *heater condenser* the water from both, while the cistern of the *heater condenser* receives steam only, and the other two cisterns condensing water only.

The *main condenser* has a pipe from near the bottom, which, when open, allows the engine to work without condensation, or, it may work with condensation, and yet no steam escape if the supply of condensing water is sufficient. In case, however, it is required that the *still condenser* shall be brought into full operation to make up for extraordinary waste, this pipe must be closed, and then the water in the *main cistern* commences to boil rapidly, and the vapor therefrom goes over into the *distilling condenser* as before stated.

In concluding this part of my subject, leaving for another opportunity the means by which I purpose to render steam of any pressure far safer than the ordinary steam which is now used, in addition to that of a certain supply of water which the "Differential" system insures, and which shows so markedly its immense advantage over all others in that, the point of greatest importance to a boiler, inasmuch as it is not only self-feeding with regard to the steam condensed, but it has also a source of supply always in action, to make up for waste, which no other condenser has (except by a separate apparatus); I will observe, that the "Differential" system does not require the amount of back pressure which I have assigned to it, unless boiling hot water or steam is required in abundance for culinary or other purposes. Where, however, this is the case, and the whole

heat can be usefully applied for drying-stoves or such purposes, more than half the fuel used under the boiler may be economized through the medium of the hot water or steam, or both, being passed through attemperators or other apparatus for that purpose.

I will, therefore, now show the comparative economic value of the "Differential" system, when working in ordinary, and only producing as much distilled water as will make up for the waste of the engine and its boiler, premising, that none of the steam which condenses in the cylinder or exhaust pipes is allowed to enter the condenser, but goes to waste.

lbs. per square inch of pressure above the atmosphere.	Degrees C. of the working steam.	
131	180	Equation No. 7. "Differential." $1{\cdot}34593 = \frac{9{\cdot}929 - 1{\cdot}045}{(661{\cdot}4 - 105),\ \frac{9{\cdot}929}{180 + 272{\cdot}479}}$

Here, then, we have a gain amounting to 34½ per cent., of which 15½ (see Equation No. 5) is due to the high pressure, and 19 to the "Differential" system of applying the steam.

For the Western waters, where people are not easily frightened by a name, I would recommend steam of not less than 200 lbs. to the square inch (and the same for locomotives, but not for ordinary boilers be it remembered), and then the following equation may serve:

lbs. per square inch of pressure above the atmosphere.	Degrees C. of the working steam.	
211	200	Equation No. 8. "Differential." $1{\cdot}42354 = \frac{15{\cdot}380 - 1{\cdot}181}{(667{\cdot}5 - 102),\frac{15{\cdot}380}{200 + 272{\cdot}479}}$

In this example, the working steam is supposed to be at 200° C., and the condenser at 105° C., while the feed water is at 102° C., and the main condenser cistern or "hot well" at 100° C.

It is useless to inquire further into the workings of the "Positive" system, because its great inferiority, except at about 38 lbs. above the atmosphere, has been fully shown before. It is true, however, that this system does admit of a higher temperature being given to the feed-water through the medium of the exhaust steam, than it is possible to attain on the "Negative" system. Heaters may be applied to abstract a few

degrees of heat from the exhaust steam and give it to the cold feed-water, but the condensed steam is necessarily lost, and with it the great object in view, *pure water under all circumstances.*

The "Differential" system, on the contrary, has no cold water to warm, for the feed water, excepting that portion of it which is to make up for the waste (and even that is warmed before entering the heater,) is not allowed to become cold at all, but is taken from the main condenser as soon as it has assumed the form of water, and pumped into the heater condenser at very nearly the boiling point, so that the demand upon that portion of the apparatus is comparatively small. The view which I have taken of the "Positive" method, may appear to be somewhat at variance with the popular one, which assigns to it a superior economy when working with steam at a high pressure, over the "Negative" method, but, this arises from my having allowed the same pressure to be applicable to both. If, however, high pressure steam cannot be economically applied on the "Negative" system, the popular point of view is doubtless the correct one. I have not before alluded to the advantages of using the steam expansively, because, that method of working is equally advantageous to all of the three systems. Nor do I think it necessary to do more than allude to the possibility of expanding high pressure steam until it shall become powerless for all useful effect, for there is a point at which expansion must cease, and that, too, long before it is too feeble to get out of the way of its successor, or has to call upon a vacuum to help it along. I speak of good honest steam, which does its own labor, and then "clears out," without waiting to be dragged out or to be kicked out.

Equations Nos. 7 and 8, speak for themselves: allow that there is a loss by the "Negative" method of 12 per cent. by condensation in the cylinder with injection, and 18 per cent. with surface condensation, and the former equation shows a gain of 53 per cent. on the one, and 64 per cent. on the other, to which in the case of sea steamers we may add 25 per cent. over all, and then we show a gain of 91 per cent. in one case, and in the other 105 per cent. on unquestionable data, without resorting to the undeniable advantage on account of the greatly reduced size of the engine.

In Equation No. 8, for even pure water, such as the Lakes have, the gain shown is 60 per cent. over the "Negative" method, with the like allowance for condensation in the cylinder of the latter, but on the "Differential" plan, at this pressure, there is none whatever. For the muddy water of the Mississippi, the gain must be fully 100 per cent.

In conclusion, I will remark, that the "Negative" system with injection, is not economical, on account of its secondary action, and large surface exposed to a great difference of temperature between the two sides of the piston, nor does it admit of the use of its condensed steam, nor the application of heaters to any useful extent. The surface condenser when applied to the same system is still less economical on account of the same defect of secondary action, and still greater difference of temperature to which the cylinder is exposed as well as to the same large surface, and although it does admit of the re-use of its condensed steam, (and filth from the cylinder,) it is greatly reduced in temperature, which has to

be restored in the boiler, but it neither provides for waste supply, nor are heaters of any use.

The "Positive" system is no better than the foregoing. True, it admits of heaters to warm the cold feed water somewhat, but throws away the very source from which it derives that warmth; a source too, of entire purity as well as of great heat, while the medium to which it is transferred is quite cold, and more or less impure, and, so far, unfit for the purpose to which it is applied.

Moreover, the complication of the machinery of the "Negative" method, together with the large space which it occupies, are most serious objections of themselves, particularly on a steamboat; and the objections to the "Negative" and the "Positive" methods, point only to such defects as show the subterfuge nature of both and the great mistake of the air pump, which, however valuable in its day, has outlived its need. Such a condenser as the "Differential" system requires, could not have been made when the air pump was first introduced, and even now, the chief difficulty encountered has been in the practical details. Per contra, the "Differential" system has no secondary action to absorb its power, nor has it any large surface or *space* to absorb its heat. It admits of the re-use of its condensed steam and throws away the filthy part, to use none but the pure, and makes prodigal provision for a supply, not only to make up for the waste occasioned thereby, but also for any other, and on board a steamer for the use of all on board, for any purpose whatever, and with any quantity to spare and at no cost. It provides, also, against lowering the temperature of the condensed steam much below the point at which it assumes the shape of water, for re-heating, even of that much and more, through the medium of heaters, before it again enters the boiler. Therefore, it retains its source of heat intact, after it has left the cylinder, and it retains its purity too, while the impure sloughs away in a soapy state, which would otherwise clog the action of the valves, and line both condenser and boiler with a coat of non-conducting grease. The waste supply is pure also, from whatever source, (however impure,) it is obtained. The machinery is of the simplest possible character, and occupies the smallest possible space, having in that respect every advantage of the "Positive" system, (with many others,) and none of its disadvantages, nor has it any other. In its refuse waste water, it has an advantage too important to be omitted, for, being at a full boiling heat it is available for cooking purposes, as well as for warming the air of houses, manufactories, or ships, for which purposes the waste water on the "Negative" system of working is quite useless, and the exhaust steam from the "Positive" one, very objectionable.

If the "*Differential*" system is not the true and *catholic* one, on which to operate the steam engine for every purpose, whether upon the land or upon the water, in the mine or on the rail, where water is plentiful, and where it is scarce; I must confess to great obliquity of mental vision, and hope soon to be enlightened, not on that subject only, but also on the amount of condensation which takes place in the cylinder, and the loss of power occasioned thereby: I confess my own inability to ascertain either, mainly, as I believe, because the condensation is many times more in a wet cylinder that it is in a dry one, and its hygrometric state is con-

tinually varying. Moreover, I believe, that low pressure steam generally causes the cylinder to be wet, while high pressure steam, at least when used expansively, causes it to be dry. That expanded steam is dry, I endeavored to prove some years ago,* and although it was a mere deduction, and as it appeared to me a necessary one from the experiments of others, it has since been proclaimed as an *original* observation of somebody else on the other side of the Atlantic.

If I have thus far rested the claims of the "Differential" system upon calculations, they are such as challenge the strictest scrutiny, being founded upon facts not liable to error, whether supported by experiments or not. Still, I have not depended upon mere calculations, but, have been engaged for years in embodying them, and at great sacrifice of money and of time, have succeeded in doing so.

My experiments have discovered to me the fact, that, with steam of about 50 lbs. above the atmosphere, cut off at two-thirds of the length of the stroke, (stroke 18 inches, piston 8 inches diameter,) making 50 strokes per minute for 10 hours per day, the condensation in the cylinder does not amount to two per cent. of the whole steam which passes through it, at least that is all which I could collect from the exhaust pipe before the steam went *up* into the condenser. With higher pressure steam and cutting off sooner, I believe there is no condensation at all in the cylinder after it has become warmed by working some time. I am well acquainted with the value deservedly attached to experiments intended to prove a foregone conclusion, arrived at in perfect good faith it may be, before the invention is put into operation, and then it is wonderful to see the performance "exceed the most sanguine expectations of the inventor." And thus, the supposed fact, instead of causing him to pause as being certainly wrong in his conclusions or in his premises, is extolled as proving the truth instead of the error of his deductions. It is like a "spiritual manifestation," which none but the victims may see. I cannot do better with reference to this sort of delusion, than by telling what happened to a very clever man in England, about 100 years ago.

Mr. Keane Fitzgerald† introduced air into the boiler of a steam engine, by means of a pipe coiled around on the inside of the bottom of it; the pipe was pierced full of holes, and the air was forced into it by means of a pair of bellows worked by the steam engine itself, and was to rise through the water in *bubbles*, and assist the formation of steam, and on trial was proved to effect a saving of *one-sixth* of the fuel, for it raised one-sixth more steam with the same fuel. The next year, however, like an honest man as he was, he stated that he was entirely deceived, for that "the bellows had never forced any air at all into the boiler, having been split withinside."

What if I should close now? It may be said that I have not shown the universal applicability of the "Differential" system, by omitting a formula for locomotives. I therefore subjoin one, showing the ordinary or "Positive" way of working, and allowing (not my allowances, but that

*July, 1847, *Journal of the Franklin Institute*, (Third Series,) Vol. xviii, pp. 134 and 229.

†1757, Philo. Trans. (Vol. l, p. 53,) also, Farey on the Steam Engine, Note, p. 245.

of Messrs. Stephenson,) 6 lbs. above the atmosphere for the back pressure occasioned by the use of the blast.

lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
131	180	Equation No. 9. "Positive." $1 - \varepsilon' = \frac{9{\cdot}929 - 1{\cdot}415}{(661{\cdot}4 - 10),\ 9{\cdot}929 \over 180 + 272{\cdot}479}$
211	200	Equation No. 10. "Differential." $1{\cdot}25257\ \varepsilon' = \frac{15{\cdot}380 - 1{\cdot}962}{(667{\cdot}5 - 115),\ 15{\cdot}380 \over 200 + 272{\cdot}479}$

The "Differential" method, shows a gain of 25¼ per cent. over the "Positive" one, partly owing to the use of steam of greater pressure; but that forms a part of the system, as will be shown hereafter; for the boiler which renders this pressure far more safe than a much lower pressure is in any other boiler whatever, is not applicable to any other system than the Differential one, although the condenser is applicable to any boiler; the "Differential" method is, therefore, entitled to the credit of the whole gain of 25¼ per cent. There will, however, be required an additional water-tender to work on the the "Differential" system for the purpose of condensation, and that is all the additional weight required, as the boiler, condenser, and engines with fuel and water in working order, will be less than on the present plan, and there are two considerations, either of which far outweighs the cost and charge of this addition; the one is the certainty of always having *pure water*, and the other, *a noiseless blast*, for a broken winded horse of flesh and bone is not, physiologically speaking, one whit more defective than a grunting, snorting iron one.

The quantity of water required for condensation is calculated at three times as much as the feed water, of which one-sixth or half as much as the feed water, is to escape in the shape of steam to the chimney, to answer the purpose of the blast, rather more economically I apprehend, than by forcing it out by the power of the engine.*

* The Messrs. Stephenson, admit that the obstruction caused by the blast, is 6 lbs. per square inch on the average, and sometimes "the whole loss of power" they say, "amounts to nearly half that of the engine," and yet, singularly enough, they state further on, that, no power is wasted upon working any machinery for the purpose, and it has the advantage of great simplicity in its application." Of course, the power is not wasted, if the labor must be performed, as they assert that it must be by the engine, but, may not the blast be taken direct from the boiler! The condenser on the "Differential" system is, to all intents and purposes, a boiler, and the blast may be taken from that at no cost whatever, for the back pressure is compensated for by the increased temperature of the feed water. The words last quoted, therefore, do apply most forcibly to the "Differential" system, but not to the "Negative" one.

The back pressure which I have allowed on the "Differential" system, (Equation No. 10,) is 14 lbs. to the square inch, and if that be not sufficient, any amount that can be required to give greater heat to the upper part of the condenser is easily attainable so as to generate the requisite force of steam for the blast. This point is of considerable importance, and forcibly illustrates the flexibility of the system, the universality of its application having, it is hoped, been established before.

And thus, I launch my *barque* on the ocean of public opinion, asking for it only the favor of an impartial consideration.

For the Journal of the Franklin Institute.

On the Evaporative Efficiency of Martin's Vertical Tubular Boilers.

By J. Vaughan Merrick.

The machinery of the United States Steamship *Susquehanna*, has recently been thoroughly refitted and furnished with four new boilers of the above description, by Merrick & Sons, Philadelphia. The boilers are of iron with brass tubes and have the following general dimensions:

Length of each boiler, (athwartships,)	11 feet.
Breadth " " (fore and aft,)	15 "
Length of vessel occupied by four boilers,	31 " 8 inches.
Breadth " " and fire-room,	31 "
The fire-room is between the two pairs of boilers, the furnaces firing athwartships, and the flues delivering into one chimney, each boiler having one-fourth of a steam drum.	
Height of boilers exclusive of steam drum,	13 " 6 inches.
" " inclusive "	15 " 10 "
Cubical space occupied by all the boilers and fire-room, being the content of a parallelopipeden included within the above circumscribing lines, throwing off the steam drum, which is between decks,	13240 cubic feet.
Number of furnaces in all boilers, 20.	
Breadth " " each	2 feet 5 inches.
Length " " "	7 "
Grate surface area in all,	338 sq. ft.
Number of tubes in all boilers, 5480.	
Length (or height) "	36 inches.
Diameter (outside) of the tubes,	2 "
Heating surface in furnaces and back connexions up to tubes,	1614 sq. feet.
" " tubes,	8508 "
" " tube boxes and connexions to smoke chimney,	1581 "
Total heating surface in all boilers,	11,703 "
Proportion of the same to grate area,	34·6 to 1·00
Flue area or calorimeter between tubes in all boilers,	42 square feet.
Proportion of the same to grate area,	1 to 8 " "
Diameter of smoke chimney,	8 feet.
" ventilating chimney within and concentric with it,	2 "
Area of annular space or chimney,	47·12
Proportion of the same to grate area,	1 to 7·4

The boilers have water bottoms, with not less than 6 inches of water space at any point; back of the furnaces these bottoms rise to the back connexions: the tube boxes are above the furnaces, and rise slightly to the front end of the boiler, where they enter the front connexions. The

boilers are of ⅜-and ½-inch best American plates, double riveted and caulked inside and out, throughout, and are well braced. The weight of all four, when empty, is 255,000 pounds. Their total weight when filled to the working level, is 440,000 pounds.

To test the economical evaporative efficiency of this form of boiler, an experiment was made on the 13th of March last, in the presence of several engineers of the Navy, the conditions and results of which were as follows:

Two boilers only, were used, and the dampers were nearly closed. The coal used was Anthracite, and of an inferior quality. The engines are fitted with Stevens' cut-off, which was adjusted and permanently fixed to cut off as follows:

Port engine, one end	3·88	Starboard engine, one end		4·60
"	4·12	"		3·35
Average per indicator card, with full throttle,			3·97	feet
Adding to this the average clearance at each end of the cylinder, and including, also, the steam passage, &c., between valves and cylinder, equal to 23,820 cubic inches, or the area of the cylinder by 6·05 * inches of stroke, or			·504	feet.
Average length of cylinder, filled at each single stroke,			4·474	"

Preserving the same level of water in the boilers, and (as nearly as could be ascertained) the same quantity of coal in the furnace, or about the same fires, and maintaining the same pressure of steam, 4200 pounds of coal were consumed, and 1615 revolutions, made and noted by register, the duration of the experiment being 3 hours 57 minutes. During this time, eleven double cards were taken on the two engines, which showed a mean pressure of steam entering the cylinders during that part of the stroke over which steam was admitted of

18·99 pounds, Port engine, Total pressure.
21·81 " Starboard " " "

of which (Pambour) the volume is 1257.

Hence, the water evaporated during the experiment was as follows: the two cylinders being 70 inches diameter = 26·71 square feet area.

$$\frac{26{\cdot}71 \times 4{\cdot}474 \times 1615 \times 4}{1257} \times 62{\cdot}5 = 38{,}372 \text{ pounds water,}$$

which being evaporated by 4200 pounds coal, gave 9·137 pounds of water per pound of fuel.

The temperature of the hot-well, was 89½°, and of the feed-water entering the boiler at (probably) 85°.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, April 17th, 1856.

John Agnew, Vice President, in the chair.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.

* This enormous amount is taken from actual measurement, and is in a great measure incident to the form of engines (inclined) with which the ship is supplied.

The minutes of the last meeting were read and approved.

Letters were read from Th. Lawson, Surgeon General, United States Army, and from the American Institute of the City of New York.

Donations were received from the Commissioners of Patents; and the Statistical Society, London; M. Hector Bossange, Paris, France; The Regents of the University of the State of New York, and William J. M'Alpine, Esq., Albany, New York; Hon. Job R. Tyson, United States Congress, and Th. Lawson, Surgeon General, U. S. A., Washington, D. C.; Prof. William Chauvenet, Annapolis, Md.; The American Institute, City of New York; The Young Men's Library Association, Cincinnati, Ohio; and from Messrs. W. Jones, Dr. H. Hartshorne, Dr. L. Turnbull, and Frederick Graff, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of February.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (3) were proposed, and the candidates proposed at the last meeting (5) were duly elected.

Mr. Washington Jones exhibited a cushion life-preserver, invented by Mr. George Fried, Jr., of this city. The cushion is of the usual form adapted for chairs, benches, settees, sofas, and other similar articles of furniture used on steamboats and other vessels.

The cushions are stuffed partially with cork shavings, and partially with hair or other soft substance, the cork being packed into the lower portion of the cushion, and being divided by a piece of muslin, or other suitable fabric, from the softer material in the upper portion. The exterior of these cushions may be made of oil cloth, leather, india-rubber, cloth, or other suitable material, to which suitable bands or straps are fastened, for securing the whole to the breast when used as a life preserver.

Mr. Fried has furnished the boats of the West Jersey Ferry Co. with his cushion life-preservers, and has taken the necessary steps for procuring letters patent.

Mr. H. Howson exhibited a model of an improved axle-box for locomotives and cars, for which a patent was granted to Mr. D. R. Perkinpine, of this city, in March last. The novelty of this invention consists in the front and bottom of the box being readily removed in one piece, allowing the journals to be easily examined and cleansed, and the oil reservoir to be removed and replaced with facility.

Mr. Howson, also, exhibited a very ingenious apparatus for removing the cut grain or grass from harvesters, invented by Samuel Comfort, Jr., and patented in March last. It consists in the employment behind the cutter bars of harvesters, of a grated platform, and a radial grating. To the former a vertical reciprocating motion is imparted, and to the latter a radial as well as tilting motion; these motions being produced by means of inclined planes, levers, rods, and cranks, operated from any moving part of the machine. The radial grating and grated platform are so arranged and operated, that the grain or grass falling on the latter, may by means of its vertical reciprocating motion, be deposited on the former,

which, by its radial movement, conveys it to one side of the machine, and by its tilting movement turns it over on to the ground. The whole is designed for the purpose of avoiding the friction produced by the use of automatic rakes, usually employed for effecting the same purpose.

Mr. Howson, also, exhibited a drawing of the boiler of the late steam ferry boat "*New Jersey.*" Mr. H. remarked, that the drawing was made from a sketch furnished by Mr. Allen, the Superintending Engineer of the Ferry Company; that he had examined the boiler minutely, and found the fire-box in a most dilapidated condition, with such a mass of bulges, and patches, that it was perfectly miraculous how it stood the pressure required. At the back, the fire-box communicated with two flues, and these, with four upper circular return flues leading to the chimney. Between the two lower flues, was a water space, or leg, in which two leaks were discovered. Mr. Howson, observes, that the situation of this leg was such, that no circulation of water could there take place, and that, consequently, sediment was likely to collect there to a dangerous extent; that the heat from the furnace, together with corrosion, had caused the leaks. The water escaping through these leaks, was instantly converted into steam, which filling the flues, forced the flame from the fire either through the doors, or through the grate bars, upwards in front of the boiler, and instantly ignited the wood work above.

Prof. Frazer concurred in Mr. Howson's remarks as to the origin of the fire on the steamboat *New Jersey;* and said that the flame in front of the boiler, would, under such circumstances, be of a blue color, as described by the witnesses at the Coroner's inquest.

The Vice President, Mr. Agnew, who, by the desire of the Coroner, had examined the boiler in conjunction with Mr. Howson and Mr. J. L. Kite, exhibited a piece of iron, which he had broken from the edge of the leak, and also agreed with Mr. Howson, as to the origin of the fire.

Mr. F. De B. Richards presented for examination two cork models —one of the Temple of Neptune at Pœstum, the other the Sybil Temple of Tivoli. Pœstum, the ancient name of which was Posidonia, is of early origin, and but little is known of its history; it was a Greek city, which is proven by the existing monuments, most conspicuous of which of the Neptune Temple, it is in fine state of preservation, having been built is a calcareous stone from the adjacent mountain; the dimensions are as follows: length 195 feet, 4 inches, breadth 78 feet, 10 inches, columns, including capitals 25 feet, 11 inches, diameter of columns 6 feet, 10 inches.

The Sybil Temple at Tivoli, near Rome, is most beautifully situated upon a projecting ledge of rocks overlooking the falls, and the valley beyond. It is a circular building 21 feet, 6 inches, in diameter, around which is an open portico, in which originally there were 18 columns, 10 of which remain. It is built of Traverline, which is beautifully represented in the cork model.

The plates, &c., exhibited, are in terra-cotta; they are perfect facsimiles both in color and design, of the Etruscan ware found at Pompei.